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Heavy Concrete Piers and Abutments for Delaware River Bridge, New York, Ontario & Western Ry., Hancock, N. Y.

By C. E. KNICKERBOCKER,* M. Am. Soc. C. E.

The line of the New York, Ontario & Western Ry. near Hancock, N. Y., has heretofore passed over the Delaware River and the tracks of the Erie R. R., on a single track iron bridge, of one plate-girder and three truss spans, a total of about 545 ft. and an approach iron viaduct some 480 ft. long. This structure is now being replaced by a new double-track steel bridge comprising one plate-girder span of 55 ft., two truss spans of 120 ft. each and one truss span of 240 ft., instead of the old bridge, and an earth fill with a 20-ft. reinforced-concrete flat arch culvert, in place of the old approach. For the new structure, the steel design is not out of the ordinary, but the piers and abutments, all of concrete, have points of interest to railway and bridge engineers.

South Abutment.

The south abutment (Figs. 1-2) located on the Pennsylvania side of the Delaware River is of special interest on account of its unusual design. It is of both plain and reinforced concrete, being 30 ft. wide, 30 ft. long on top and about 57 ft. high from the ground. Theoretically it is but two bents, made of plain concrete, spaced about 25 ft. from center to center and braced together with a series of arches and cross braces or struts of reinforced concrete. These bents support a solid deck of reinforced concrete which is about 2½ ft. thick. The two front posts rest on concrete foundations each 14 ft. 6 ins. wide, and 21 ft. long, supported on gravel. The foundations were reinforced with old rail horizontally and crosswise spaced 18 ins. c. to c. There are vertical rails 8 ft. long and 3 ft. apart which extend 4 ft. into the posts. The posts are plain concrete 8 ft. × 14 ft. 5 ins. at the bottom. The front and sides are on a batter of ½-in. in 12 ins. and the back plumb. At a height of 36 ft. 5 ins. above the foundation there is an offset of 5 ft. in the front of the posts which forms the bridge seat. The posts then continue up for 17 ft. 5 ins. to the deck, being plumb on front and back and the batter of ½-in. in 12 ins. on the sides. The rear posts rest on concrete foundations each 11 ft. square, the same method of reinforcement being used as in the front posts. The rear foundations are 6 ft. higher than the front foundation on account of the slope of the ground. The posts are plain concrete 7 ft. 6 ins. × 8 ft. at the bottom. The front and back are plumb and the sides on a batter of ½-in. in 12 ins., lining up and corresponding with the front posts. The rear posts are 47 ft. 10 ins. high and extend to the deck.

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FIG. 1. SOUTH ABUTMENT, DELAWARE RIVER BRIDGE, N. Y., O. & W. RY., HANCOCK, N. Y.

At a distance of 16 ft. 4 ins. above the front foundation there is a strut on each side connecting the front and rear posts. The under side of this strut is a 14-ft. arch, that being the distance between the posts. The strut at the crown is 2 ft. 6 ins. deep and is the same width as the posts at this point. At this same elevation there are two cross struts connecting the two front posts and the two rear posts. They are 4 ft. wide and 2 ft. 6 ins. thick, located about at the center of the posts. Where the struts connect with the posts the lower sides are rounded by a quarter of an 8-ft. arch. All of the struts are reinforced with ⅞-in. corrugated rods, which extend into the posts. At a distance of 15 ft. 1 in. above the first panel of struts there is a strut on each side connecting the front and rear posts similar to those and of the same dimensions in the first panel. The strut connecting the rear posts at this elevation is similar to that in the first panel, and the strut connecting the front posts at this elevation is 5 ft. wide by 2 ft. 6 ins. deep with the quarter of the 8-ft. arch on the lower side where it joins the posts. The top of this strut is at the same elevation as the offset in the front posts which forms the bridge seat and makes the bridge seat the full width from out to out of the front posts.

At a distance of 14 ft. above the bridge seat there is a strut on each side connecting the front and rear posts similar to those in the first panel, except that at the crown they are 3 ft. 5 ins. deep instead of 2 ft. 6 ins. The tops of these struts are level with the bottom of the deck and form the seat for the deck reinforcement.

The deck reinforcement (Fig. 3) consists of one 24-in. I-beam 31 ft. long and 21 20-in. I-beams, 31 ft. long, supported on four 85-lb. rails, two on each side, embedded in the struts connecting the front and rear posts. The beams were spaced 16¾ ins. apart and fastened together with 1-in. bolts threaded on both ends, having two nuts on each end. The deck was also reinforced with vertical corrugated rods extending into longitudinal struts, and with wire mesh fastened to the under side of the I-beams, which holds the 2 ins. of concrete under the beams. The deck at the center is 2 ft. 7 ins. thick, sloping to 2 ft. 4 ins. thick at each corner for drainage. A parapet wall 18 ins. wide on top extends across the front and each side level with the base of rail. A 3-in. weep hole was made through the parapet at each front corner. At the under side of the deck at each post is a quarter of an 8-ft. arch, 4 ft. wide made to correspond with the cross struts in the two lower panels.

The deck was made waterproof with three applications of asphalt and pitch. The forms for the concrete were made of 2 × 6-in. yellow pine studding and 1 × 5-in. spruce on the face sides, and 1 × 10-in. hemlock on covered sides. The form was built to the top of the first panel and the concreting finished; the form was then carried to the bridge seat and concreting finished; it

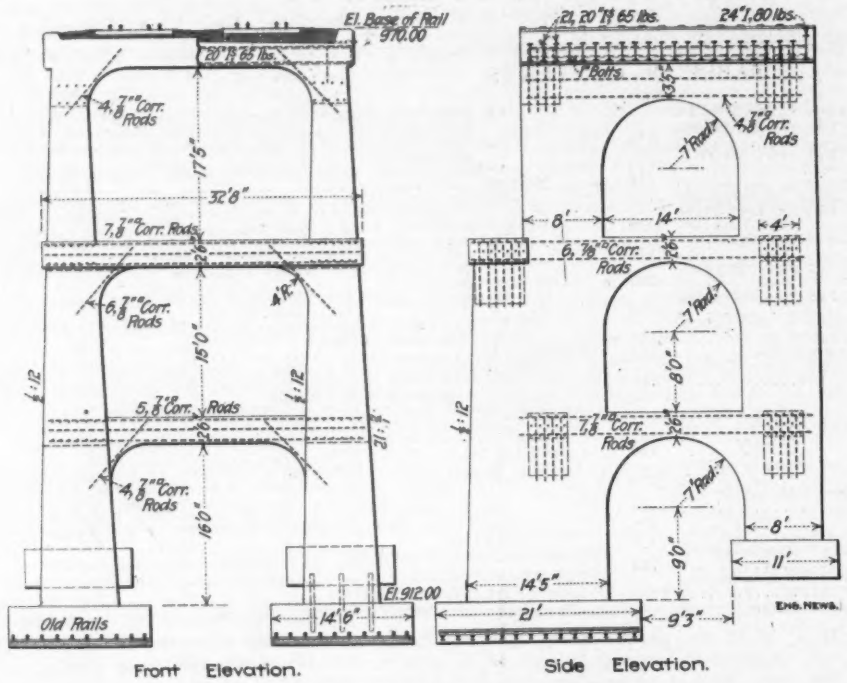


FIG. 2. DETAILS OF SOUTH ABUTMENT.

was then carried to the under side of the deck and finished to that point; the form for the deck and parapets was then made. The form from the bottom up was left until all concreting was finished, the lower form being used to brace the upper forms. The concrete to the top of the bridge seat was mixed by a continuous machine located on the ground at the east side and a little to the front of the abutment and was placed with two 1-yd. buckets raised by a derrick located at the middle and about 30 ft. east of the abutment. The hoisting engine was located directly back of the derrick about 40 ft. away. The concrete material was dumped from cars through the old viaduct and hauled to the mixer by carts. The water for the concrete, hoisting engine and mixer was supplied by a pump located on the river bank. This pump also supplied the water for all the work, a pipe being laid the full length of the old bridge. The concreting with the derrick was only carried on by day. The remainder of the concrete from the bridge seat up was mixed and placed by hand, the work being carried on day and night. The mixing board was located on the new fill about 100 ft. south of the abutment at which point the fill then ended, and the concrete was wheeled in place on a runway built along the old viaduct. The material was shoveled from cars onto the fill near the mixing board. The I-beam reinforcement in the deck was placed from the old viaduct by a derrick car. The abutment contained 805 cu. yds. of concrete and was built in 31 days.

FIG. 3. I-BEAM REINFORCEMENT OF FLOOR SLAB, SOUTH ABUTMENT.

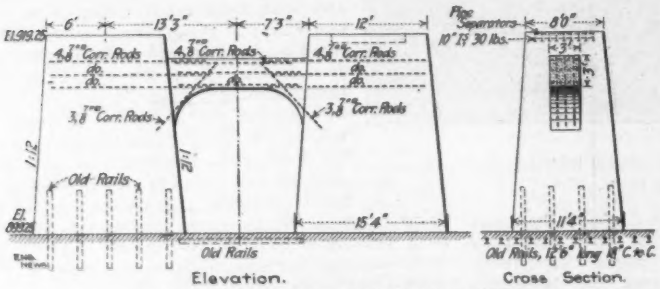
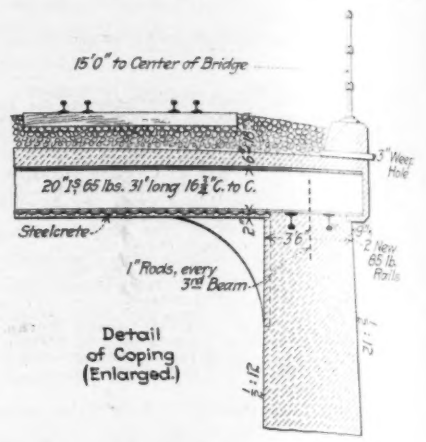


FIG. 4. DETAILS OF TWO RIVER PIERS.

The fill was then completed around the abutment, the material being unloaded from the old viaduct and from the track laid on the new fill. The cost of forms and labor on this abutment was greater than it would have been on a gravity section abutment, but the cost of labor and material for the gravity section would have exceeded the cost of the abutment as built. The new style abutment also has an advantage over the gravity section on account of the material running through it and supporting practically nothing but its own weight, part of the bridge and the live load, and does not act as a retaining wall. The small surface on the back of the abutment and the fill running through it leaves but little chance for the earth pressure to move or tip it as is usually the case in filling back of a high abutment. When the fill was completed there was not the slightest settlement or movement noticeable in the new abutment. This abutment supports the south end of the 120-ft. span.


15'0" to Center of Bridge
3" Weep Hole
20"I 65 lbs. 31' long 16½" C. to C.
Steelcrete
2" New 65 lb. Rails
1" Rods, every 3rd Beam
Detail of Coping (Enlarged.)

Piers.

The two piers which support the 240-ft. span are of the same design, as shown in Fig. 4. The foundations are of concrete reinforced with old rail laid longitudinally the full length of the foundation and spaced 18 ins. c. to c., with a layer of old rail laid across and on top of the longitudinal rails the full width of the foundation. These rails were placed about 2 ft. above the bottom of the foundation. The piers are about 20 ft. high above the foundations, built in two sections or separate piers 26 ft. 6 ins. c. to c. and connected with a strut. Each section or pier is 8 × 12 ft. on top with a batter of 1 in 12 on all sides and connected to the foundation with vertical rails 3 ft. apart and 8 ft. long extending into the foundation 4 ft. The strut connecting the piers is 3 ft. wide and 3 ft. deep arched on the under side with one-quarter of an 8-ft. arch where it joins on the separate piers, the top of the strut being 2 ft. 6 ins. below the top of the pier. This strut is reinforced and connected with each section by corrugated rods. In the top of each section or pier is a grillage made of

Fig. 5. View Looking South Along Bridge.

nine 9-in. 21-lb. I-beams set level with the top of the pier on which the posts of the 240-ft. span rests.

In addition to these masonry structures there is one more pier somewhat similar in design to the last two described, the north abutment, a solid concrete gravity section with long, high sloping wing walls on either side, and a 20-ft. flat reinforced-concrete arch through the ap-

proach fill, forming an opening for a highway passing under the line of the railway.

Work on the filling and substructure of the new bridge was commenced June 1, 1911, and completed Sept. 15, 1911. The structure was designed and constructed under the supervision of the writer, Mr. Howard O'Connor being the Assistant Engineer in charge on the ground, and the MacDonald Construction Co., 149 Broadway, New York City, the contractors.

Rapid Destruction of Timber Beams From Dry Rot.*

The scarcity of good lumber and the constantly increasing use of cheaper grades and poorer varieties is bringing to the front the necessity of more careful treatment and precautions in the use of timber in building construction, if anywhere near adequate service is to be gotten from it. Instances of extensive damage to mill frames from dry rot have not in the past been very plentiful, owing, doubtless, to the fact that only the soundest and best timber was used for this purpose. But now that builders must accept and use poorer qualities it is becoming evident that unless precautions are taken, such timber is likely to prove a very poor building material.

As slow-burning construction has had much to do with reducing the fire loss in mills, and as it is becoming increasingly difficult to secure heavy timber of good quality for use in such construction, any influence which tends to weaken or destroy existing or future structures is of interest. An instance of the damage that may result from a fire in a building where timbers are already partly destroyed by dry rot is given in the fire which caused the destruction of the Gledhill Wall Paper Factory, New York City, in the latter part of the year 1909.

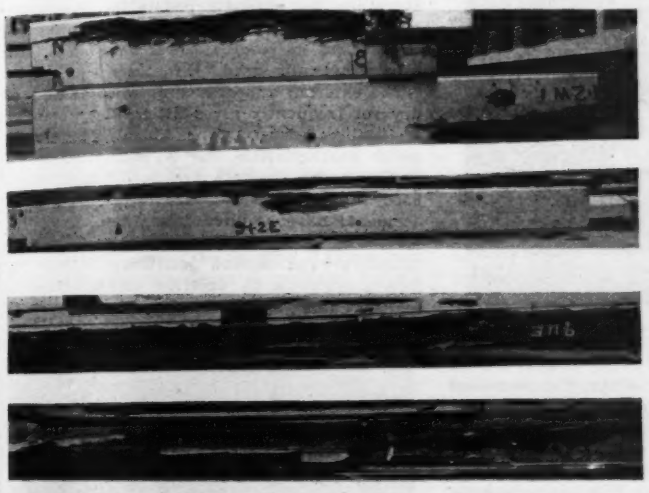


FIG. 1. SPECIMEN BEAMS TAKEN FROM THE MILL OF THE CANADIAN SPOOL COTTON CO., SHOWING EFFECT OF DRY ROT.

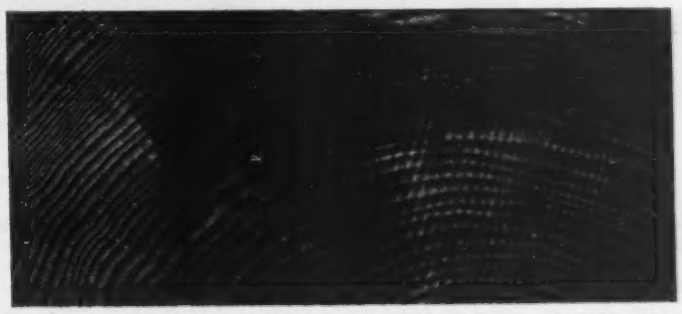


FIG. 2. SECTION OF BEAM 812 W, SUPPOSED TO BE CUBAN PINE.

The results of an investigation of this building after the fire by Prof. I. H. Woolson, of Columbia University, were published in Engineering News of Dec. 2, 1909. Prof. Woolson found that the collapse of the floors and the resulting entire loss of the building and contents was due to the fact that the tops of the posts had already been badly eaten by dry rot, and that their failure would ultimately have occurred even had the fire not happened. Prof. Woolson closed his article with a statement that it was fortunate that yellow pine which is now used almost exclusively in mill construction apparently resisted this disease best.

It appears, however, from a recent experience elsewhere, that some yellow pine is very susceptible to dry rot under certain conditions. Damage from dry rot in the mill of the Canadian Spool Cotton Co. at Maisonneuve, Que., has been so extensive that the entire wooden frame is being replaced with steel, although the mill was built less than four years ago.

The first defect was noticed in the spring of 1910, just two years after the mill was begun, when a serious settlement of the floors occurred. This failure was caused by the crushing of 3-in. block fillers between the posts of each story, but in replacing the blocks with cast-iron chairs it was discovered that a considerable number of beams were affected by dry rot, and that the rotting had already progressed so far that it was necessary to replace them. An investigation was then started to determine as far as possible the cause of this rapid rotting.

It is understood that the lumber for the frame arrived in the latter part of the summer of 1907 and lay on the ground during the following winter. Construction work was begun in April, 1908, and the building was roofed in July, but up to September the windows had not been put in. The floor-beams were of two 8 × 18-in. timbers with a ⅞-in. space between. On top of the timbers were floor planks 2 × 5 ins. on edge, with ⅞-in. soft board under floor and ⅞-in. birch top floor. The beams were painted and a batten applied to cover the ⅞-in. space between them about December, 1908.

The architect's specifications are understood to have called for the timbers to be "of the best quality long-leafed Georgia pine." Specifications of mill engineers throughout New England are found, in general, to call for floor and roof timbers to be of Georgia long-leafed pine, subject to the Interstate Rules of 1905 for the classification and inspection of yellow pine lumber. By the general terms of these rules all lumber must be sound commercial long-leafed yellow pine, well manufactured, full to size and saw butted, and free from unsound loose hollow knots, worm-holes and knot-holes, through shakes or round shakes that show on the surface, etc. Pine combining large coarse knots with cross grain is excluded under these rules.

The usual specifications call for timber used in floor and roof beams to be of "Merchantable" inspection and for columns to be of "Prime" inspection. "Merchantable" inspection requires that sizes 9 ins. and over shall show some heart wood the entire length of the piece on two opposite sides. Wane may be allowed one-eighth the width of the piece provided not over 10% of the pieces of any one size shall show such wane. "Prime" inspection requires that pieces shall show two-thirds heart on the face and heart on two-thirds of length of edges, excepting when the width exceeds the thickness by 3 ins. or over, then it shall show heart on the edge for one-half the length.

In the case of this building it is not easy to determine whether a specification calling for "the best quality of long-leafed Georgia pine" had been complied with or not; but this is probably the case with many lumber specifications. It is doubtful if, at the time this building was constructed, it were possible to obtain sufficient material of the "best Georgia pine." It is a well known fact that much of the lumber sold in the market to-day as Georgia pine may be of the inferior varieties of Cuban or Loblolly pine. While botanically these trees are easily distinguished from each other and from the so-called Georgia pine, it is extremely difficult after once cut up into lumber for even an expert to surely pronounce from what variety of tree the lumber was made.

Loblolly and Cuban pine have not been considered suitable for use in important structures without previous antiseptic treatment, although the latter should make an excellent material with such treatment. Under the name of "slash pine" Cuban pine is now cut and sold without discrimination with long-leafed pine. Loblolly pine resembles Cuban pine in the structure of the wood and is extensively marketed as North Carolina pine. According to Bulletin 13 of the Bureau of Forestry, "Loblolly pine above 2 ft. in diameter is frequently affected with dry or red rot. Until late years it has been cut only on special orders for low priced stuff intended only for temporary purposes. It is the least valuable pine in the Southern Atlantic forests, owing to its speedy decay under the combined influence of moisture and air."

All the badly rotted beams thus far removed from this mill have every appearance of being Loblolly or Cuban pine. None of the finer grained material, which is probably long or short-leafed pine, had rotted seriously. There was some rot in the sap wood, but it was not extensive. Of the 245 beams removed, 20 were badly rotted, 119 were coarse grained, probably Cuban and Loblolly pine, 121 were medium grained, generally with coarser grain at the center and finer at the outside, corresponding with the description in Bulletin 13 of short-leafed pine.

Whatever the specifications under which lumber is purchased may be, the existing scarcity of first quality timber and the resulting efforts to work in poorer grades make absolutely necessary a rigid inspection of the material after it has arrived on the ground. Sufficient allowance is not made for changes in the quality of yellow pine. For some uses the light weight quick-growing wood will satisfy every requirement, particularly if given antiseptic treatment. It is not safe, however, to assume that it can be used with equally good results under the same conditions as the dense slow-growing material now rapidly disappearing from the lumber market.

Another cause which may have contributed to the rapid rot of these timbers is the manner in which they were treated previous to their use in the building. A wood to which the merulius lacrymans mycelium (a fungus causing dry rot) has once gained admission presents a difficult problem, as the living protoplasm of the plant appears to have the power of separating itself into sections which may be dried for years, and on being again thoroughly soaked with water, quickly assume vegetative form and grow rapidly. Dr. Hartig, a German investigator, thinks that lumber is not infrequently infected by spores, either while in logs or after it has been cut and piled in lumber yards.

The timber used in this mill was subjected to an ideal treatment for the growth of fungus. It may have been infected while lying in the yard covered with snow in the winter of 1907 and

*From data collected by Messrs. C. H. Smith and F. J. Hoxie, Engineers and Special Inspectors, for the Associated Factory Mutual Fire Insurance Companies, 31 Milk St., Boston, Mass.

1908, possibly from the remains of diseased stumps, etc., or a structure previously located there. The infectious nature of the living fungus was shown by an infected beam which was left on the floor of one of the rooms. In a few weeks it started a growth on the floor under it.

Polyporous vaporarius and other members of the polyporous family of fungi are common causes of destruction of basement floors, frame building sills, posts and other timbers near or in contact with the earth. Several large polyporous plants were found in the mill yard under the piles of beams recently removed. Many trees and stumps in the yard are infected with fungi of this family. None of the merulius lacrymans were discovered, but it could hardly have been expected that they would be found above ground in dry weather. Moreover, the earth was not removed from any of the stumps and part of the yard had been recently filled.

It is therefore likely that the lumber was infected when put into the building. It is doubtful if it would have become inoculated afterward. The comparatively low temperature which is maintained, and the presence of water on the floors under the wet spinning machinery were favorable to fungus growth. Moreover, Dr. Mez, another German investigator, has shown that the growth of the merulius lacrymans, once started in a piece of timber, is able to produce sufficient water for its requirements by decomposition of the cellulose. It is therefore difficult to cure this disease by air drying unless accompanied by an elevated temperature.

Another contributing cause in this case was probably to some extent the application of a heavy coat of oil paint before the timber had a chance to dry out. It is a matter of common engineering knowledge that a thick coat of oil paint applied to the exposed sides of unseasoned timber will, in many cases, apparently cause the destruction of the timber in a short time from dry rot. Dr. Hartig especially cautions against this practice.

It probably makes little difference whether the material is green and full of sap, or whether it has been soaked with water immediately before being put into the structure and covered with paint. Thoroughly dry specimens once infected with the fungus can be brought into vigorous growth by soaking in pure water for five or six hours and then leaving them in a moist atmosphere.

The placing of a batten over the opening between the two beams before the timber had had a chance to dry out contributed to the same end. It is sometimes recommended that the space be left open to prevent dry rot, but it is doubtful if the opening is of much value unless the timbers are thin and there is an opening at the top also, so that the air may circulate. Such an arrangement is objectionable from the increased fire hazard.

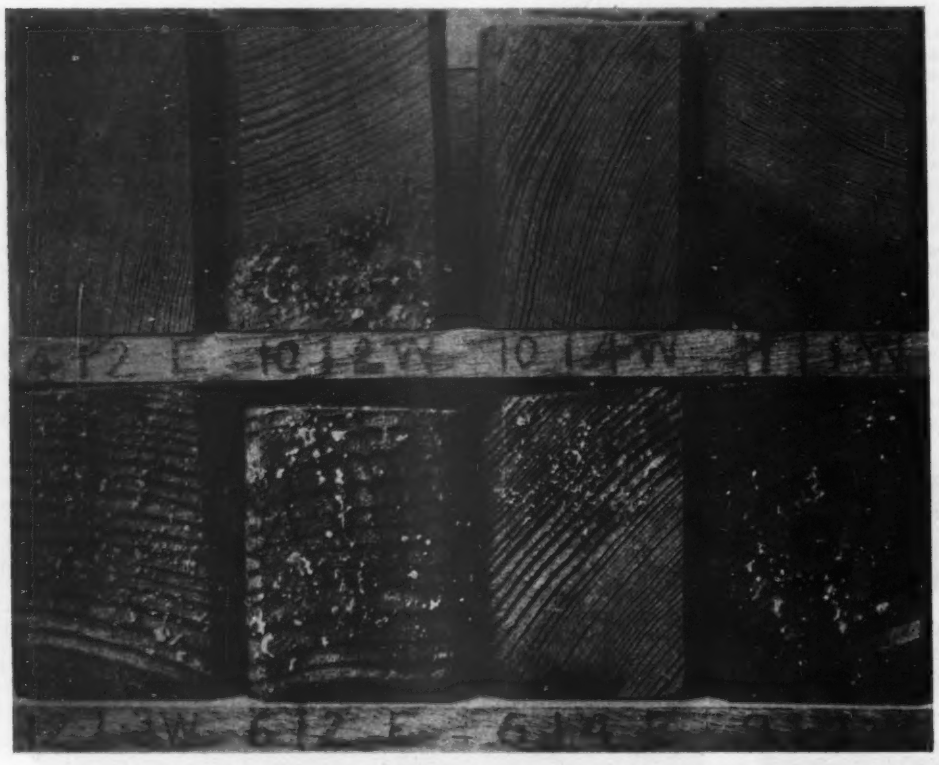


FIG. 3. FUNGUS CULTURES ON SPECIMENS TAKEN FROM AFFECTED BEAMS.

CONCLUSIONS. — The heavy close grained "long-leafed Georgia pine," which is heavier and stronger than the other varieties, is fast disappearing in the large sizes. This is unavoidable and must be taken into careful consideration in selecting stock for buildings of slow-burning mill construction in the present and future. It is probable that poor grades of timber can and in the future will have to be used in structures. A light piece of timber is weaker than a heavy piece in approximately the proportion of their respective weights, but this can be allowed for in designing so that ample strength and stiffness is obtained from the poorer material. Light and porous timber is susceptible to fungus growth, particularly in rooms subject to moisture and low temperatures. There is no question of the danger of using such timber without previous antiseptic treatment.

It is apparent that if beam 812 W (Fig. 1 first beam at top, Fig. 2) is Cuban pine, as it is assumed to be, this species is readily attacked by fungi, although its weight and general appearance would indicate a good stout material. This specimen weighed 40.7 lbs. per cu. ft. kiln dried or 41.9 lbs. per cu. ft. air dried. The amount of water absorbed per cu. ft., 11.7 lbs., was, however, significant, as was also the small amount of pitch, only 4%. It is not possible to accurately estimate the porosity of wood, but in testing these specimens the attempt was made by taking blocks which were cut so far as possible from the sound heart wood. They were then kiln dried, weighed and soaked in water for 24 hours. The sap wood is far more absorptive than the heart wood, and it is always against the moist floor planks, and is readily attacked by fungi of all kinds.

A fungus once started in the sap wood may extend to the summer heart wood of the coarse grained stock. The cells of wood once pierced by fungi take up water like a sponge. This is shown in the case of the beam 812 W, previously referred to, the infected portion of which absorbed 33.8 lbs. of water per cu. ft., rendering it considerably heavier than water, while the unaffected part of the beam absorbed only 11.7 lbs. of water. It was found that generally the most badly rotted timbers were those which absorbed the most water. Good quality long-leafed and short-leafed pine was found to absorb but from 3 to 6 lbs. of water per cu. ft. by these tests. The exceptions were specimens from the heart of beams where the heart was a small proportion of the total section, and the rot was chiefly in the sap wood.

The amount of rosin in wood is another factor which affects its ability to resist decay. Certain fungus growths stop abruptly at the heart wood after rapidly ravaging the sap wood, as cultures made on sections of these beams have shown. On the other hand, many fungi that attack living trees inhabit the heart wood only. This is no doubt caused by a power of resistance peculiar to living protoplasm. Hollow trees are an example of this. Some of the polyporous family attack heart wood, but they are not very common or destructive in structural timber unless it is subjected to unusually severe conditions. The heart wood saturated with rosin not only affords mechanical resistance to the fungus mycelium but strongly resists the absorption of water. Rosin has been suggested for preserving timber, but no records are at hand of its having been practically used.

The external appearance of wood affected with dry rot frequently gives little, if any, indication of its diseased condition. This is a very treacherous characteristic, for a badly infected timber, with its strength practically gone, may be used in an important structure. Many serious accidents have resulted from this cause.

It is of value to identify in a general way a fungus growth causing destruction in timber before attempting to describe curative measures, for the damaging action of some are more easily

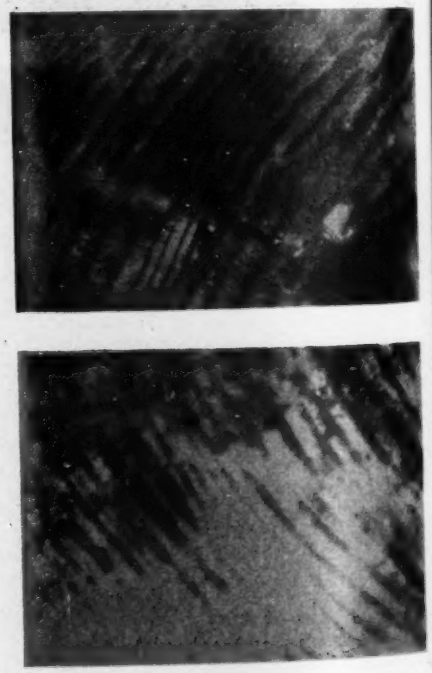


Fig. 4. Effect of Fungus on Photographic Plates.

arrested than that of others. Kindred varieties of wood-destroying fungi are frequently confounded, even in scientific literature. Practically all forms of fungus diseases of timber are included under the name of "dry rot." Science has not yet furnished the means of absolutely distinguishing between kindred growths.

The cultures of specimens taken from this mill (Fig. 3) were examined by a microscope after

four weeks' growth, and the appearance of the mycelium indicated the possibility of merulius lacrymans. Only one specimen showed unmistakably the characteristic buckle cell. Five or six different varieties of fungus mold were growing luxuriantly on most of the other specimens except those of fine-grained heart wood. These molds, at this writing, had not been identified, and some of them are probably secondary phenomena, feeding either on the decomposing primary growth or on the rotted wood cells.

The absence of well defined living plants of the merulius lacrymans in the cultures does not prove that they may not have existed there when the timber was in place in the mill, as most of it had lain several weeks on the ground outside of the building, a part being acted upon by the summer sunshine. The microscopic appearance of the plants on the beams themselves indicated merulius lacrymans both in color and form.

Owing to the fact that wood which is honeycombed with mycelium frequently shows no signs of being rotten, it was suspected that some other phenomena might follow the fungus. As the wood had become permeable to both air and water through the action of the fungus, and the brown color is frequently brought out by soaking, oxidation was suggested. A piece of the beam 812 W containing fungus, badly rotted wood, sound wood and a pitch pocket was taken and placed between two X-ray photographic plates held 0.01-in. from its two faces, towards the end of the grain.

After a week's exposure to the wood in total darkness the plates were developed. Stronger impressions were found where the wood had been attacked by fungus than where it was saturated with pitch, although pitch is known to have a strong photographic action. Fig. 4 shows prints from these plates. This phenomenon was discovered in England about twelve years ago by Sir John Russell, and is caused by many, if not all, substances capable of automatic oxidation, and is probably a measure of the rapidity of this action. The photographic impression is probably caused by the ionization of the oxygen of the air in the process of automatic oxidation (the same phenomenon as that of spontaneous combustion), or it may be the decomposition of the fungus, similar to the light-producing fungus-infected wood known as will-o'-the-wisp, caused, according to Dr. Hartig, by the decomposition in wood cells of the mycelium of the fungus agaricus melleus.

Much attention is now being given to antiseptic treatment of timber to prevent rot, and in Europe much progress has already been made. Most of the large railway systems of this country have taken the matter up and the treatment of ties, telegraph poles and bridge timbers is quite common. The ordinary methods employed in timber preservation are familiar to most engineers. The treatment has two valuable results. The first is the sterilization of the timber, that is the killing of living fungus and spores or fungus in a resting state. In many processes, as in boiling, steam or kiln drying, this is the only result. The second effect is placing a poisonous or resistant material in the cells of the wood with the object of preventing the germination of spores or growth of fungus in the future. For this purpose permanence and insolubility of the impregnating material are important if the lumber is to be exposed to moisture.

Wood which has been seasoning for several years may be attacked and destroyed if it contains the fungus spores and is soaked with water sufficiently to render this fungus active. Without doubt, if the timber is thoroughly sterilized and dried by a combination of steaming, or boiling and kiln drying, a heavy coat of oil paint is at once beneficial in keeping out both fungus and water until the timber is in place in the structure. On the other hand, if wet or green timber already infected is covered with paint, the evaporation of moisture is prevented and conditions are made ideal for the development of the fungus. If the paint film were absolutely continuous, it would probably have some retarding action on wet infected wood by cutting off the air supply necessary to the growth of the fungus. But this condition is never realized in practice, as the paint peels from the wet wood, season cracks open, and the tops of the beams are rarely painted. It is also quite possible that linseed oil paint may serve as a carrier of oxygen, as recent investigations of the corrosion of metals suggest.

Having briefly discussed the prevention of timber rot, the next question is how to cure it when once started. With merulius lacrymans this is a difficult problem. All investigators agree that its cure is expensive and at best uncertain. Its sporous state is one of the most troublesome features, for otherwise it could be destroyed by thorough drying. It has been suggested that an entire structure be heated to 105° F. or more. In a structure of considerable size, with heavy walls and beams, this is difficult to accomplish and requires a long time for the heat to penetrate. One investigator has declared it practically impossible to sufficiently heat heavy brick or masonry walls to effectively destroy the fungus in the ends of beams.

Another method of killing dry rot that has been suggested is painting the affected wood with a solution of bichloride of mercury in wood alcohol. On a large beam, particularly if it has been painted, it is doubtful if sufficient poison can be gotten into the timber to be effective. A better means suggested is to use this material, or an aqueous solution of bichloride of mercury or chloride of zinc, applied to the center of the beam by means of small holes bored in from the top every 2 or 3 ft. The aqueous solution is less expensive, but the wood alcohol is more penetrating. The permeability of infected wood should encourage the diffusion of the poison to the affected parts. It is hoped to be able to make experiments along these lines on full-sized beams taken from this mill, determining the value of the treatment by means of cultures.

Curative measures should be carried out with caution on important structures, as the growth has always extended farther than can be determined by careful examination. The strength of a structure may be seriously reduced before warning is given. A rough index of the extent of the fungus growth might be obtained by the amount of liquid absorbed. A thoroughly infected timber may take up more than half its volume of water, while sound timbers will absorb but little.

Weight and rosin contained are not infallible guides to good lumber, but heavy fine-grained stock with 5% or more of rosin should be reliable. The heart can be easily distinguished from sap wood in fine-grained lumber without extracting the rosin. Where fungus is suspected in wood a determination of the amount of water which it will absorb should be of value. If present, living fungus can easily be cultivated on a specimen of the wood; even the growth of a harmless fungus indicates the presence of abundant food material. The absence of growth may indicate that the sample is not infected, or is able to resist infection. To determine which is the case, the specimen should be cultivated in contact with living fungus.

A recent government publication in England states that dry rot is increasing in frequency in that country. German and American articles indicate that the same is true in these countries. But it is doubtful if this increase is due any more to the infectious nature of the disease than to the increasing use of poorer lumber. It is evident from examination of mill frames in the course of erection at the present time that large quantities of light coarse-grained Southern pine is being used. In two mill frames recently examined in Central Canada much sapwood was found already covered with fungus. In one case this material had been bought as the best quality of Southern pine at $34 per M. for beams and $28 per M. for planking. The only attempt in those structures at antiseptic treatment of the timbers was to daub a little creosote on the ends of beams which were to be embedded in the walls and on the ends of columns.

This coarse-grained sappy material averages much poorer than that which has been used for mill construction in the past, and it is more subject to fungus attack than many of the so-called soft woods. Its use may not be followed by disaster if the atmosphere of the building is kept generally dry. It is hazardous, however, and it would be advisable to avoid untreated coarse-grained Southern pine in important structures, particularly if the material is of light weight. It is difficult, if not impossible, to distinguish the heart wood in much of this material, and much of this material has no heart wood.

The Effect of Napthalene in Road Tars.*

The effect of napthalene upon the consistency of refined tars to be used as road binders is the subject of an investigation made by Messrs. Prevost Hubbard and Clifton N. Draper, of the U. S. Office of Public Roads. This study is the first of a series on the principal chemical constituents of road-tar preparations and their effect on the usefulness of those materials.

Napthalene is a white crystal melting at 79° C. and boiling at 218° C. Its specific gravity at 15° C. is 1.1517. It is extremely volatile and has a very characteristic odor—that of the familiar "moth-balls"; it volatilizes far below its boiling point. It is slightly soluble in hot water and dissolves easily in alcohol, ether, fatty or essential oils, acetic acid and in the lighter tar distillates.

Napthalene is not considered a binding material, but it has been known to serve as a flux for the binding constituents of tars, in spite of being a solid; hard pitch and napthalene combine to form a soft product. Therefore, a comparison of its fluxing value with less volatile tar distillates was thought useful.

Consistency was judged by a float apparatus which has been developed for the Office of Public Roads and has been found to give comparative results. First, there is an aluminum cup 3½ ins. in diameter into the bottom of which is screwed a small brass conical collar ⅞-in. high, ⅝-in. in diameter at the top and ½-in. at the bottom. In making a test, the brass collar is placed with the small end down on a brass plate which has been previously amalgamated with mercury; a small quantity of the material to be distilled is heated in a metal-spoon with care to prevent volatilization and formation of air bubbles, and poured into the collar in a thin stream until slightly above the top. The surplus is removed with a spatula after cooling. Collar and plate are then placed in a dish of ice water, maintained at 5° C. Another dish is filled three-fourths full of water, which is kept heated to any desired temperature (within 0.5° C.) After the material to be tested has been kept in the ice water for some 15 minutes, the collar, with contents, is screwed into the aluminum cup and floated in the warmed bath. As the plug of bituminous material becomes warm, it is gradually forced upward and out of the collar until the water causes the cup to sink. The time of floating is taken as a measure of the consistency.

For this study, 55° and 80° C. were adopted as most suitable temperatures. Samples were made up with a napthalene content varying from 0.5 to 30%. An increase in fluidity of mixtures was readily seen as the napthalene was added. With 20%, the product was fluid at normal temperatures. The napthalene combined readily and no traces of free napthalene could be seen, except above 15 to 20%. The fluxing effect of the napthalene was marked at first, but rapidly became less above 4%. There was practically no difference in the consistency of tar which was mixed with napthalene and with napthalene-free distillate in the same proportions. The carbon content of the tar had practically no effect on the consistency induced by different percentages of napthalene or distillate.

The effect of napthalene on the fluidity of tar was considered important in road construction, since all coal tars contain napthalene in amounts varying from 0 to 10%. The trouble lies in the high volatility of napthalene as the tar with a high content will lose its original characteristics in service. Of two road tars of the same consistency, one with a small napthalene content and the other with a high one, the small-content tar would maintain its original condition in service longer than the other.

*Brief Abstract of Circular 96, U. S. Office of Public Roads.

A Centrifugal Clarifier and Filter.*

The machine shown in the accompanying illustrations has been devised for clearing oils, varnishes, syrups, extracts, and all sorts of liquids carrying foreign matter which may vary all the way from coarse sediment to the finest flocculent precipitate. There is, first, a clarifying process which essentially is a centrifugal separation. Then there is a final filtration, through any desired material but commonly through filter paper. Centrifugal force here merely assists by an automatic cleaning of the filtering surfaces.

As seen in Fig. 1, the machine has the general external lines of a familiar centrifugal cream

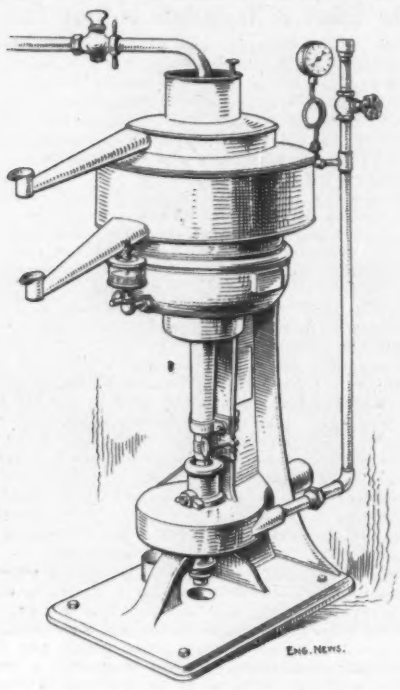


Fig. 1. The De Laval Centrifugal Clarifier and Filter.
(Steam-Turbine Driven.)

separator. The similarity, however, almost entirely stops there. The clarifying and filtering processes are carried on in two separate compartments of a revolving bowl which is enclosed in a stationary frame or casing. The lower section of the bowl, Fig. 2, is the clarifying chamber, and above this is placed the filter assembled as a complete separate mechanical unit. In the clarifier is a series of conical pressed-steel disks, one above the other, 1/32-in. apart. They are held rigidly in the position shown by key wings on the hollow receiving shaft in the center and by vanes at the bottom of the revolving bowl. The same shaft which supports the disks also carries the filter, which consists of a built-up series of filtering disks and supporting and draining plates. The filter unit may be removed intact by taking off the sheet-metal covers (Fig. 1) and the hood rings (Fig. 2) at the top and side of the revolving bowl.

The raw liquid enters through the receiving shaft at *A* from a feeding tube and drops to the bottom of the clarifying compartment and is forced outward by centrifugal action to the periphery of this compartment, where it is subjected to what may be called a "forced gravitational" pressure of some 300 lbs. per sq. in. Under these conditions, the bulk of the heaviest sediment is here caused to "settle" outward. From here, the liquid flows upward and inward between the several conical disks noted. These divide the liquid into thin layers and give it rapid motion through the skin friction of the large contact surfaces. Foreign matter carried by the liquids is rapidly settled from the thin layers and collects on the underside of the disks, gradually working its way down and out to the periphery of the clarifying chamber. The liquid passes, with at least 98% of the foreign matter removed, to the periphery of the second compartment of the bowl.

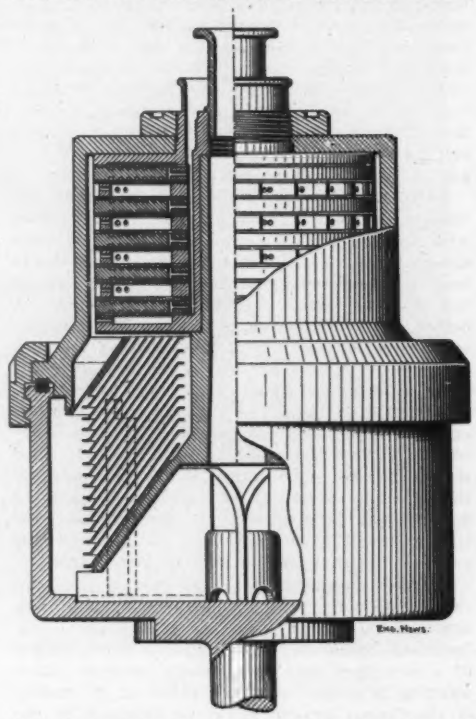


Fig. 2. Revolving Bowl of De Laval Clarifier and Filter.

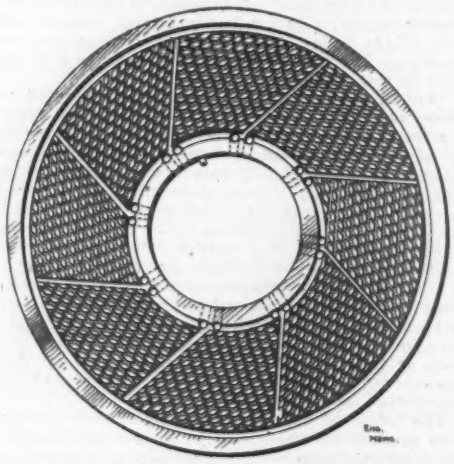


Fig. 3. Grooved Collecting Plate.

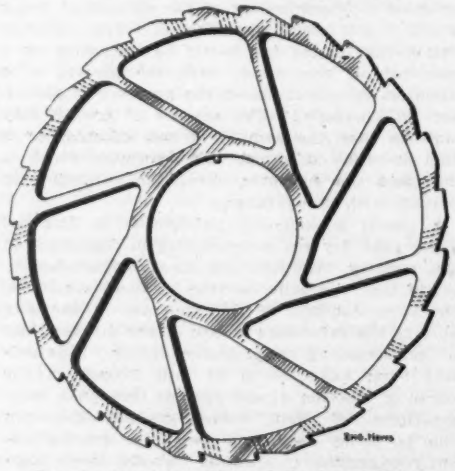


Fig. 4. Retaining Ring of De Laval Filter.

The filter is a multiple-type; that is, the liquid flows in parallel streams. The parts, of which the filter is built up, are shown in Figs. 2, 3 and 4. The retaining rings have compartments opening through small holes to filter chamber; the collecting plate has multitude of grooves leading to several channels and these in turn lead to holes serving as exits to the outflow. The retaining ring and grooved plate are larger than the shaft of the spider which supports them and are centered with it by spacing studs, seen in Figs. 3 and 4. The filter spider itself is cast as a hollow receiving shaft integral with a flat bottom plate and a groove for retaining ring, as may be seen from Fig. 2. In assembling the unit, first a filter disk is placed on the spider, then a grooved plate, another filter disk, a retaining ring and so on, ending with a grooved plate, a filter disk and the top casting.

With the machine in operation the liquid is forced from the space, *D*, above the clarifying disks into the narrow annular space, *E*, from where it passes through small holes, shown in Fig. 5, to the compartments, *F*. From here, it flows through the filtering material, along the grooves and channels of the collecting plate, Fig. 4, and finally passes out to the annular outflow space, *I*. From here it flows to the discharge point, *J*, out into the lower cover, shown in Fig. 1, and thence into any desired vessel. The hollow receiving shaft has a bushing with a large lip, *K*, to prevent mixing of the raw and filtered liquid through over-delivery of the feed pipe. The overflow is thrown by centrifugal force from *K* into the top or overflow cover, shown in Fig. 1, and may be collected as desired through the spout there seen. The discharge of the filtered liquid from the lip, *J*, is accomplished similarly, and centrifugal force directs the flow into the lower or receiving cover.

The filtering surface in the compartments, *F*, of the retaining ring, being horizontal, are practically self-cleaning for sediment or precipitate as it collects in any appreciable volume on the filtered material, is thrown to the periphery of the compartment by centrifugal force. In this way clogging of the filters is considerably postponed, and it is not necessary to clean the filter as often as the clarifying chamber.

These machines are built in sizes to suit various requirements and may be driven by small steam turbines, by belt power or by hand. The steam turbine type shown in Fig. 1 is 46 ins. high and stands on a base 18 × 24 ins.

*From information furnished by the De Laval Separator Co., 165 Broadway, New York City.

The Manufacture of Wagons and Carriages in the United States during 1909 and 1904 is the subject of a preliminary report by the U. S. Census Bureau. The general comparisons of growth are shown in the appended table. "Cost of materials" includes fuel, power and heat, and mill supplies. "Value added by manufacture" show difference between cost of raw materials and final value of products at the factory. The total product has no specific bearing on the sales for the year. The establishments covered by these figures include those making bodies, tops, cushions, hubs, felloes, spokes, wheels, etc., as well as complete vehicles, but it does not include small shops.

	1909.	Per cent. of increase, 1904-1909.
Number of establishments	5,492	†2
Capital	$175,474,000	15
Cost of materials used	$81,951,000	6
Salaries and wages	$45,555,000	1
Salaries	$7,960,000	21
Wages	$37,595,000	†2
Miscellaneous expenses	$11,670,000	†4
Value of products	$159,893,000	3
Value added by manufacture (product less cost of materials)	$77,942,000	†1
Employees:		
Number of salaried officials and clerks	6,802	8
Average number of wage earners employed during the year	69,928	†10
	126,032	19
Primary horsepower		
Number:*		
Carriages family and pleasure	828,411	†12
	587,685	†9
Wagons	154,631	16
Business	428,952	†15
Farm	3,102	†12
Government, municipal, etc.		
Public conveyances (cabs, hacks, hansoms, hotel coaches, omnibuses, etc.)	2,243	†17
	190,899	†21
Sleighs and sleds	544	172
Automobiles		

*In addition, 14,908 carriages, 42,115 wagons, 104 public conveyances, and 8,209 sleighs and sleds were made by 121 establishments engaged primarily in the manufacture of other products.
†Decrease.

A Reinforced-Concrete Wharf at Balboa, Canal Zone.*

Additional docking facilities being required immediately by the Panama R. R. at Balboa, it was decided to construct a reinforced-concrete dock, 706 ft. long by 55 ft. wide, located so as to form a part of the ultimate terminal scheme contemplated for the Pacific entrance to the canal. A tidal inlet, with entrance at north end of sand dock, crossed the dock site. It was necessary to shut this off by a cofferdam, constructed near the entrance. Two centrifugal pumps were installed for keeping the old bed of the inlet dry. The dock will thus be constructed on what is almost entirely dry land, and dredging may be started whenever the piers are completed. The general design is shown in Fig. 1.

FOUNDATIONS.—The character of the material for foundations was determined by a line of borings and a test pit, sunk along the outer edge of the proposed dock. For about 20 ft. sand is encountered; this changes to a heavy bluish-gray clay which continues some distance, when a layer of sand and gravel a few feet thick is found overlying the bedrock. The latter is a variety of argillaceous sandstone, and was found in the borings at depths varying from 60 to 70 ft. below mean sea level.

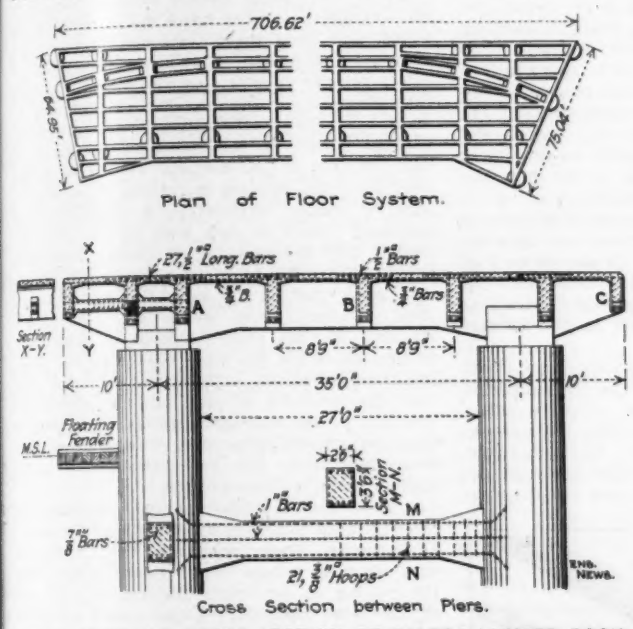


FIG. 1. PLAN AND CROSS SECTION OF BALBOA LUMBER DOCK, PANAMA CANAL.

CONSTRUCTION OF PIERS.—In building the piers a heavily reinforced-concrete shell (Fig. 2), built in 6-ft. sections, is forced down to rock and the interior then filled with concrete. The bottom section is a hollow frustum of a cone, interior diameter 6 ft. throughout, exterior diameter 10 ft. at the base, tapering to 8 ft. at the top. The purpose of the enlarged footing thus formed, is to minimize skin friction while the pier is going down and also to bring the unit pressure on the foundation well within the allowable limit. From the top of the footing section the 8-ft. exterior diameter is maintained to the top of the entire pier, giving a cylindrical shell 1 ft. in thickness. A steel shoe attached to the bottom of the footing serves at once as the bottom concrete form and also as a cutting edge.

Two methods of construction have been employed; in the first the footing was modeled, partially filled with concrete and lowered by crane into position. The successive sections, after subsequently completing the footing, were then built up in place whenever the progress of sinking required. This interfered with the sinking operations, the steel and forms were difficult to handle on account of the limited standing room, the concrete had to be placed laboriously by hand and required a reasonable length of time to set before the work of sinking could be resumed. These difficulties led to casting 6-ft. sections on the ground near one of the mixers. In the vertical reinforcement does not pass through the joint between sections, but bond is given by means of six vertical iron rods, made continuous by stout square junctions threaded at each end to receive the rods. By this method any number of sections may be built in advance and become well seasoned before required for use. They are handled by crane and lowered into position, the rods which project from the preceding section passing through holes left in the section being lowered. The top surface of each section is so molded as to leave the inner half of the ring about 1 in. higher than the outer half; the lower surface corresponds. The sections then fit into each other, the joint being strengthened by a rich cement mortar. The footing and 3 ft. of cylindrical shell are made as before, the upper surface of this 3-ft. section being prepared to receive one of the sections cast on the ground.

Collapsible steel forms are employed in 6-ft. lengths for the inside and 3-ft. lengths for the outside forms. The footing has a special outside form.

The concrete used in the shell is a 1:2:4 mixture; that for the filling is 1:3:5. The interior of the cylinder is reinforced against bending with old French rails, as shown in section of pier.

SINKING PIERS.—It was at first proposed to sink the piers by water jets, pipes passing down through the shell and contracting into a nozzle at the bottom being inserted for this purpose. The material, especially the clay stratum, is so heavy, compact and stiff that a pressure of about 120 lbs. per sq. in. brought about scarcely any penetration. Orangepeel excavation in the upper strata proved to be less efficient than hand excavation, so the latter has been finally resorted to and carried out wherever practicable.

There were on hand several Star drills, and these have been utilized as windlasses for raising and lowering specially constructed buckets of about 5 cu. ft. capacity into the piers. Two or three men work with shovels at the bottom of the pit, taking material from under the shoe and gradually leveling off; the caissons then sink of their own weight.

At about 25 ft. depth a brown, spongy material, saturated with sulphuretted hydrogen gas, is encountered. While passing through this stratum, the laborers' eyes become very much inflamed, hospial treatment being necessary in some cases.

At about elevation —43, the clay becomes saturated and extremely soft and the caissons take a sudden drop of from 3 to 6 ft., due solely to their weight, no excavation being necessary to accomplish this. The material forces its way up inside the caisson from the bottom to distances of from 12 to 15 ft. From this point down water is present practically until the rock is met with, difficulty of its control making it impracticable to continue hand excavation. The orangepeel bucket, operated from one of the cranes, accomplishes the work, and just before reaching rock the material again becomes almost impervious, allowing the men to enter and adjust the steel shoe to the foundation. The shoe is embedded for about 1 ft. in the rock, and a conical depression is formed at the bottom, either by hand or by means of a small charge of dynamite; this gives the concrete used for filling a firm bond with rock foundation.

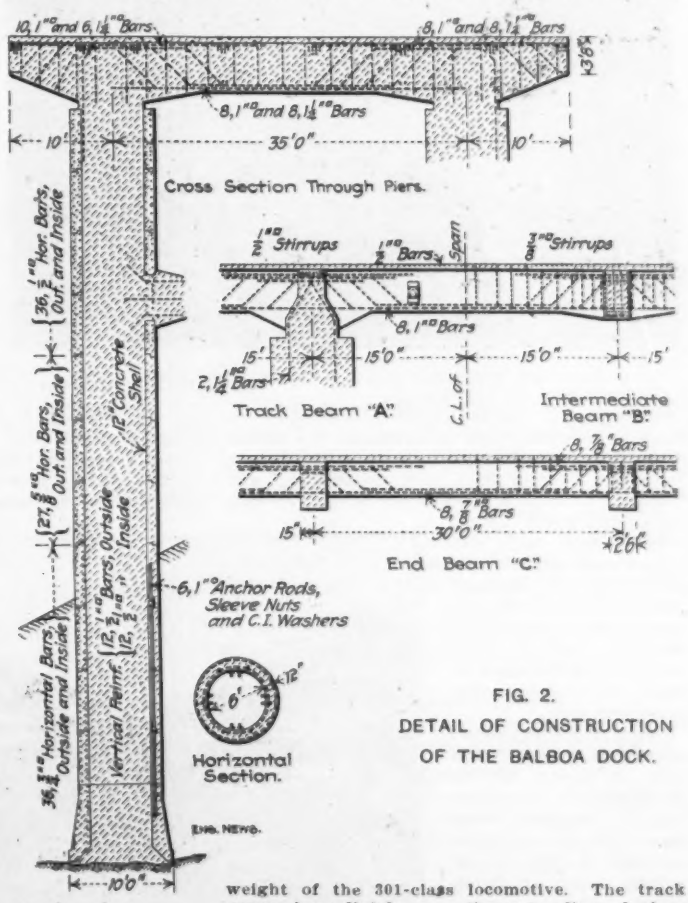


FIG. 2. DETAIL OF CONSTRUCTION OF THE BALBOA DOCK.

SUPERSTRUCTURE.—The tie girders for giving stiffness to the piers run transversely between piers, and longitudinally between outside piers at an elevation of —10. The cross section is 3 ft. 6 ins. deep by 2 ft. 6 ins. wide. The floor system consists of girders running perpendicular to axis of dock, cross sectional dimensions 4 ft. 8 ins. deep by 2 ft. 6 ins. wide. Arrangements of reinforcing steel is shown in the figures herewith. The girders support a system of floor beams running longitudinally along the dock 3 ft. 9 ins. deep by 1 ft. 3 ins. wide. On top of the whole is a reinforced slab 6 ins. thick. The system is designed to support a uniformly distributed live load of 400 lbs. per sq. ft., and a concentrated live load over the track beams equivalent to the weight of the 301-class locomotive. The track comes immediately over the outer line of piers, curving off at each end over the extra piers shown in the plan of the dock.

PLANT.—The main elements comprise two locomotive cranes, one having capacity of 15 tons at 10 ft., the other 20 tons at 12 ft.; three concrete mixers, two of ½-cu. yd. and the third of ⅓-cu. yd. capacity; six pumps, for keeping the cylinders dry during sinking; a marine boiler, which, however, furnishes power to other units besides the dock proper; and about a dozen drills. The pumps are operated by steam from the boiler, and the cranes and one mixer by self-generated steam; the remainder of the plant by compressed air.

PROGRESS OF WORK.—Caisson construction was begun the last week in February, and work on sinking the first caisson began March 22. Work was commenced on the inner line of piers starting at Bent 20, and carried toward the nearer end of the dock, the outer corresponding piers being placed as work progressed. By a modification in the original plan the oblique row of piers at this end of the dock was omitted. On June 1, 1911, work was started on the 19th bent, and during the remainder of the month at bents 9, 10, 11 and 12. The holes for piers at bents 4, 5 and 6 were being prepared at the end of the month. When the caissons originally started have all reached rock, work on the flooring may be carried on here simultaneously with work on substructure at other portions of the dock.

*From 1911 Annual Report of the Isthmian Canal Commission.

FIELD AND OFFICE

A Unique Bridge Built of Old Rails, Bas Obispo, Panama Canal.

The various uses which have been found for a vast amount of junk material left by the French is one of the things which most impresses the observing visitor in the Panama Canal Zone. Old cylindrical boilers have been plugged and used as channel buoys, old hulks have been built over into serviceable steam tenders and launches, many machines at the Balboa shops have histories dating back to the French days, old dredges have been patched up and made to do good service, while no end of uses have been found for old rails. These have been used extensively for telephone and telegraph poles, for curbs for cement walks, for reinforcing the sides of dump cars, for reinforcing concrete, and for many other purposes.

FIG. 1. BRIDGE BUILT OF OLD RAILS, BAS OBISPO, C. Z.

One of the most unique uses found for these old rails is shown in the accompanying illustration, Fig. 1. This bridge was built as a practice exercise by the U. S. Marine Corps at Camp Elliott, which is nearby. A rough general plan was prepared by Lieut. R. L. Shepard, U. S. M. C., but the material was prepared and the construction work done under the immediate supervision of a quartermaster sergeant with a detail of six privates. For the concrete work in the piers an additional detail of 15 men was employed. None of the men had had any experience in structural work, and the roughest kinds of tools were used.

The bridge spans a small stream opposite the railway station at Bas Obispo. It has a total length of 150 ft., with a middle span, between piers, of 69 ft. 8½ ins. The approach spans vary from 21 ft. 6 ins. to 23 ft. 6 ins. The width of the bridge is 9 ft. 6 ins., and the height above the water of the creek is 31 ft. The concrete piers are rectangular 2 ft. × 12 ft.

The bridge was constructed by first building the bases of the concrete piers. Two rails were erected in each in an upright position cross-braced with rods and wire cable as is shown in Fig. 2. These served as a falsework in erecting the floor system and as reinforcement in the completed piers.

The floor-beams, which in the completed structure rest on top of the concrete piers, are made of two rails bound together, base to base, by U-shaped straps. The two outside stringers are also composed of two rails united as in the floor-beams, the lower one resting on the piers and the upper on the tops of the floor-beams. The whole floor system consists of eight rails arranged as shown in Fig. 3. The lower rail of the outside stringers was not used in the shorter spans.

The middle span of 69 ft. 8½ ins. is supported by an improvised arch made of rails. The diagonal struts are made of three rails each, clamped together with U straps. The upper part of the arch is made of two rails fastened together, base to base. Each pair of diagonal struts is cross braced with horizontal rods and diagonal tension members made of wire cable. Wire cables are also attached to the middle of the struts from the tops of the piers.

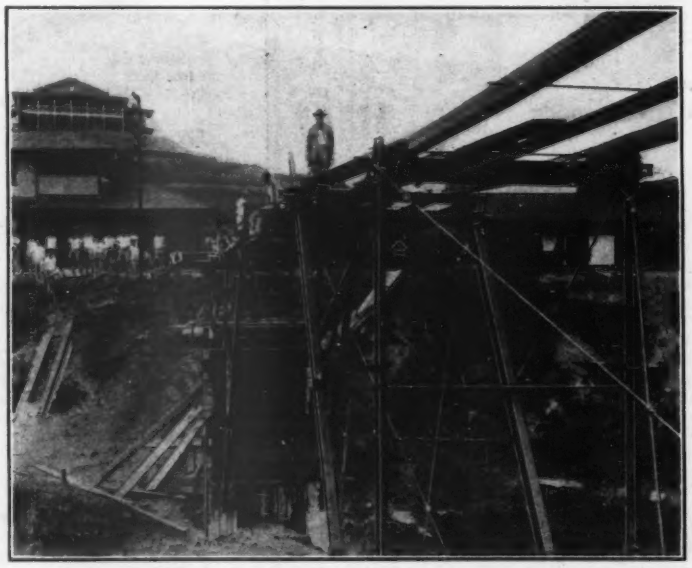


FIG. 2. U. S. MARINES BUILDING A 150-FT. BRIDGE OF OLD RAILS.

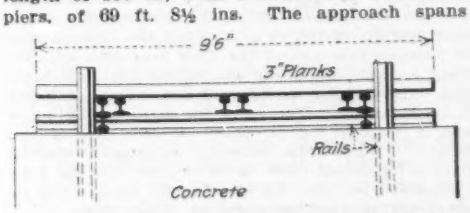


Fig. 3. Floor System of Bridge Built of Old Rails.

At the bases these diagonals are bedded in concrete. The connection between the diagonal and horizontal members is made by cutting off the lower of the diagonal rails and placing a cross rail at each pair, against which the horizontal member of each arch bears. The lower horizontal rail is supported by clamps to the upper which rests upon cross rails supported on the ends of the upper rail of the three forming the diagonal strut. The middle rail of the diagonal projects above the floor as shown in the photograph. The floor stringers over the arch are carried on four pairs of rails used as floor-beams.

The bridge thus composed almost entirely of loose rails was formally opened in the presence of Col. Goethals on Aug. 26, and [illegible]en a rather severe test. It not only successfully held the weight of the entire battalion of [illegible]1 men (30.6 tons), but of 70 men on a single panel, marking time at "double time."

A Field Test for the Strength of Concrete.

Inasmuch as the conditions of make-up, material, weather, supervision, etc., all seriously affect concrete, it is obviously difficult to predict with any certainty the strength of the concrete in any structure from the tests made on any concrete or from a general knowledge of the average behavior of similar concretes. It is, however, quite necessary that the unit strengths of all members in a structure should be known, not only to govern design but also to control the time of form removal. The ultimate strength of concrete, for use in design, is established from the averages of many tests in all parts of the world, and from these tests certain values are accepted for design, allowing a fair factor of safety for the various elements which may alter that strength on any one job. Undoubtedly in many cases these safe values could be increased without danger to the structure, but since the real strength of the material cannot be known until after the building is completed and the design, of course, unalterable, a safety factor is necessary which is very high for the best material. For the removal of forms, however, it should be possible to devise some test on a separate piece, cast at the same time as the structural concrete, from which the earliest safe strength of that concrete could be determined. Several plans for this have been suggested ranging from the simple expedient of driving a spike into the concrete of the building, gaging the strength by the resistance, to elaborate strength tests on cement briquettes, concrete cubes and elementary beam and slab forms similar in design to those in the structure.

A new test to determine this strength has recently been proposed by Mr. F. von Emperger, of Germany. This consists in the manufacture of a series of simple beams simultaneously with the casting of the concrete in the structure and of the same material. These beams are to be tested at intervals until the concrete shows a compressive strength sufficiently in excess of that for which the structure was designed to warrant the removal of the forms and the support of the structure and its loads by its own members. Experience will soon establish the proper period of tests and probably not more than two will have to be made for any one section of the structure.

The special feature of the scheme is that the beams are to be made of such section, length and reinforcement as to produce a definite and simple relation between the breaking load of the test and the compressive strength of the concrete, and at the same time to guarantee the failure of the beam through failure in compression of the concrete. For instance, a beam 4 × 5 ins. in section, with two ⅝-in. round rods, 1 in. from the bottom plane, when tested over a span of 42 ins. with the load carried equally to the one-third points, would fail at a compression in the concrete of 20 lbs. plus one-third the total rupturing load. For such a beam it would be very easy to set up a testing frame with the beam supports fixed at 42 ins. Then, for example, if the load causing failure on a certain beam was 7,740 lbs., the compressive rupturing value of that concrete would be 2,600 lbs. per sq. in. From this figure it would be decided that the concrete was amply strong to permit the removal of forms.

Simplification of the design of the beams would allow of most elementary form work and of their very rapid and easy casting, while the ease of setting up a simple framework and of applying a direct load would be much greater than in the testing procedure for tensile briquettes of compression cubes. In view of the regular winter grist of concrete failures from premature removal of forms, which is not starting, the application of some such system as that noted should be looked on with favor.

Steel T-Squares and Steel Edges for Drawing Boards.

By GEORGE W. COLLES.*

For a good many years the writer experimented with straight edges for T-squares, drawing boards and triangles. He found T-square blades and heads generally crooked when purchased. Triangles as a rule are not 90°, as can easily be found by drawing a line with one and then turning it over and drawing another line close to the first; furthermore, the edges are not straight, especially near the ends, but are almost invariably convex (not concave) so that they rock even on a true straight-edge.

In many kinds of drafting the small lack of parallelism or rectangularity between the lines is not important; but in machine design, especially the design of large and complicated machines on a scale of ¼ or ⅛-in. to the foot, it becomes vital. In designing such machines, different portions of the structures are separately drawn up in assembled relation and subsequently assembled into a whole, and it is entirely impossible to put each dimension on the sketch-drawing as it is selected. In such cases, then, the lines should not vary from parallelism and straightness more than 1/64 of an inch, because this may make a difference of 1/16 or ⅛-in. in the final scaling off of the dimensions for the working-drawings.

Experience had satisfied me that wood as a material for straight edges of any kind was out of the question. A wooden straight edge absolutely straight to-day will be crooked to-morrow. No wood that I have tried as yet is free from warping. Hard rubber is no better than wood, and has the added disadvantage that it attracts and holds dust electrically and then distributes it upon the paper. It also oxidizes superficially

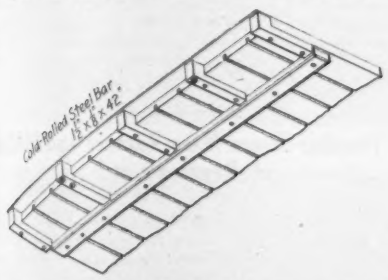


Fig. 1. Steel Edge Applied to a Large Drawing Board or Table.
(View from under side.)

and rubs off upon the paper. Celluloid is really a considerable improvement on wood, in that it does not warp and twist of its own accord as wood does, but it is too soft and will not remain in adjustment long.

This brings us down to metal as the last resort, and it is the only thing that will do the work. I had an aluminum T-square head made and it has worked splendidly. It is so light that it does not overbalance a short blade when on the edge of the board, and I believe I am right in saying that aluminum would not soil the paper, though I have not tried it as a blade. Steel, on the other hand, is inclined to cover the paper surface with a coating of black dirt and it lacks the transparent edge of the celluloid, but it is the only thing that is satisfactory for fine work.

DRAWING-BOARD EDGES. — Steel straight-edges for clamping on the edges of drawing-boards have been made before, but as usually made they are expensive and not very practical. To rabbet out the edge and set in a straight edge is expensive and spoils the table surface. The problem was solved by the writer for a table with a 42-in. edge by screwing five maple brackets to the side of the table in the manner shown in Fig. 1. Two screw-holes were tapped in a cold-rolled steel bar 1½ × ⅜ × 42 ins., and two corresponding holes through two of the brackets, and the steel bar secured by passing stove-bolts up through the brackets (with washers under the heads) and into the screw-holes in the bar. All five of the brackets were secured to the under side of the table by two screws, except one of

*404 Alhambra Bldg., Milwaukee, Wis.

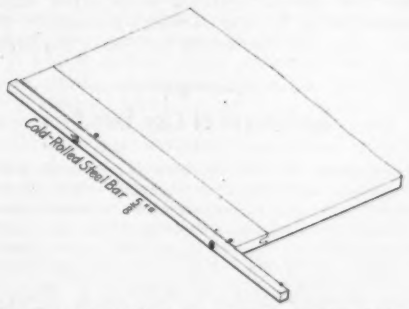


Fig. 2. Steel Edge for a Small Drawing Board.
(Size of board, 24 × 36 ins., or under.)

the two which carried a stove-bolt, which was secured to the table by only one screw, thus leaving it free to swing enough to take up differences in expansion and contraction. If the brackets support the bar unevenly, their level can be adjusted by means of paper shims.

The cold-rolled bar is not quite straight enough for work with an ordinary T-square and should be planed off. I find that it can be made straighter by a face-cut of a milling-tool than on a planer, although the tool leaves marks on the planed edge. If an extra long T-square head be adopted, say 15 ins., planing may be unnecessary.

For a small hand-board a different and simpler arrangement is to be adopted. The straight-edge for the hand-board is simply a cold-rolled bar ⅝-in. square, and having a length several inches greater than the side of the board. One face of this is planed off and two holes bored through this face, these holes being countersunk halfway to admit the heads of roundhead screws. This bar is attached to the side of the board by two screws, and to prevent splitting it will be found desirable to place a couple of smaller screws on opposite sides of the hole, extending from one side to the other of the board.

The holes are so placed that the upper surface of the bar is flush with the face of the board, and its lower end projects several inches beyond it. (See Fig. 2.) This projecting end will not cause serious inconvenience, and it will be found a great help toward drawing horizontal and vertical lines in the correct position near the bottom of the board. The screw-holes are made larger than the screw-shanks, so as to admit a little play before tightening them, and a couple of paper washers are placed on the screw-shanks between the bar and the board, so that the bar stands a little off from the board, which prevents it from being bent, as would be the case if any part of the edge of the board projects. The bar can, of course, be used interchangeably on different boards by using a standard spacing of screw-holes.

It is not necessary to have the bar perfectly straight, nor even visibly straight, as compared with a steel scale, but this should be remembered: that the shorter the T-square head, the straighter the bar must be, and by using a long steel head even a considerable inaccuracy (provided it is not a convexity) of the bar may be neutralized.

T-SQUARES.—The T-square head is of almost equal importance with the fixed straight-edge. Steel T-squares are for sale in the market, and those wishing to save trouble can buy them; the writer prefers to make his own, which is easily done at an expense no greater, when results are compared, for the purpose both of accuracy and adjustability. Steel straight-edges of different length, which should be thin to give them some flexibility, are used for the blades. A shorter set having a length of 9 to 15 ins., and thick, are used for the heads.

A block 2½ × ½ × ½-in. is secured by screws to the middle of the head and forms a means of attachment for a pivot-screw by which the blade is secured to the head. (See Fig. 3.) The screw is so placed that the end of the blade projects about ¾-in. beyond the back edge of the head. A second block 4 × ½ × ¼-in. is secured by two screws to this projecting end at right-angles to the blade. The screws are threaded into this block in such manner that their ends abut upon the back-edge of the head, and the T-square is ready, with interchangeable heads and interchangeable blades, adjustable to any angle within 10° of the horizontal.

Many persons object to steel blades on account of the dirt they spread over the paper, as aforesaid. The larger part of it, however, is derived from matter which adheres to the steel and not from the metal itself, either directly or by rusting. Practically I have not been seriously inconvenienced; it is only necessary to keep the

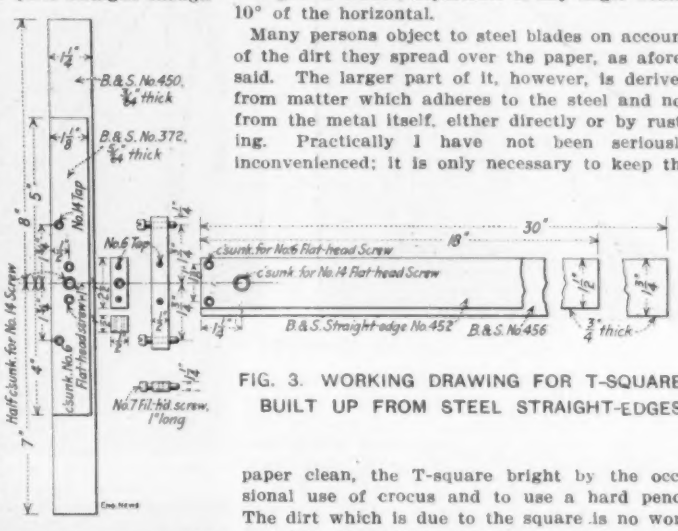


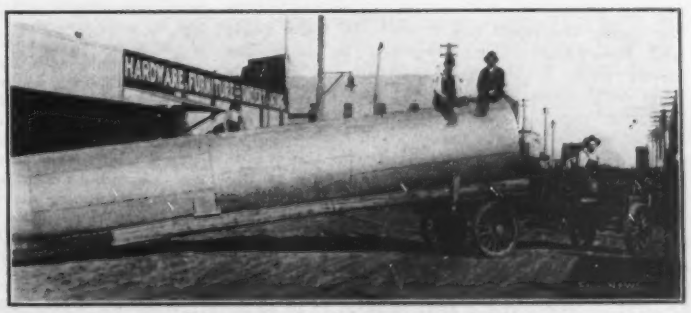
FIG. 3. WORKING DRAWING FOR T-SQUARES BUILT UP FROM STEEL STRAIGHT-EDGES.

paper clean, the T-square bright by the occasional use of crocus and to use a hard pencil. The dirt which is due to the square is no worse certainly than that which accumulates on the paper without it, and can be removed by a cleaning rubber.

Hauling a Large Steel Standpipe Section by a Motor Truck.

The half-tone herewith reproduced from a photograph sent us by Mr. R. Beresford, of the Avery Company, Peoria, Ill., shows how a large steel standpipe section, 30 ft. long and 5 ft. in diameter, was hauled through the streets of the town of Liberal, Kans. The standpipe was built for the water-works of Liberal. The pipe section was laid on a cradle made of two telegraph poles, and this cradle was slung on the rear of the truck. In this way it was hauled three-fourths of a mile through the streets of the town.

The truck used is a 3-ton Avery truck, owned by the firm of Blake & Sons, of the town of Liberal, and used by the firm for its regular haulage work; it was loaned to the town for this special job.

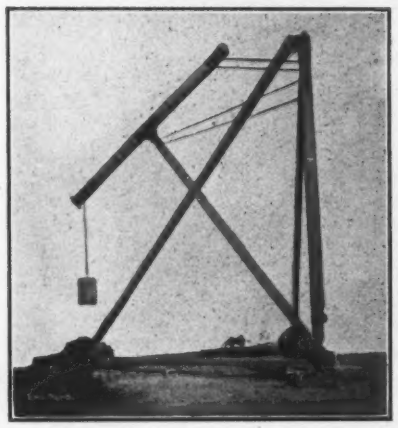


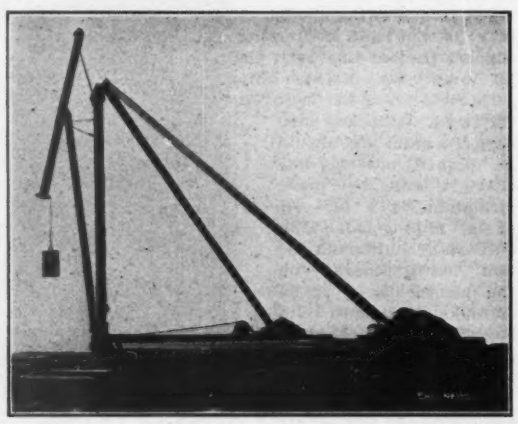
MOTOR TRUCK HAULING A 5 × 30-FT. STANDPIPE SECTION ON A CRADLE OF TWO TELEGRAPH POLES.

A New Type of Derrick.

The accompanying illustrations show a new type of derrick, which is of interest not only because it is new, but because it is the first successful attempt to replace the time honored figure 4 derrick, one of the simplest, and in all probability one of the oldest, known devices for handling building material. In place of the usual boom and cables, the new derrick has a compound boom made of the ordinary hinged boom with a balanced cross-beam at its top, which is fastened to the top of the mast by a link of steel rods.

The mast and supporting legs are identical with the well-known form of stiff-leg derrick. To the end of the boom is attached the cross-beam, which turns on a pin bearing about its middle point. To the other end of this beam is





THE McVEIGH-DOUGHERTY DERRICK.

fastened the pulley over which the cable for raising the load is run; the other end of the beam is fastened to the top of the mast by two steel rods, having pin connections, which permit free movement of the end of the cross-beam.

For ordinary loads but one cable is used to carry and raise the suspended weight, although the end of the beam may be easily equipped with as large a block and as many cables as required. The load cable passes over the top of the beam, over a pulley near its upper end, and thence to the mast and winch.

The boom is moved by a cable through a single-sheave block from a winch on the derrick mast. If by accident this cable breaks, the boom will not fall with its load, as in the case of the ordinary type, but drops only far enough to bring the load, the cross-beam, connecting link and itself into a state of equilibrium.

The derrick is built either of timber or structural steel, and operated by hand, steam or electric power. When built of timber the cross-beam is composed of two timbers bolted together with a steel reinforcing plate vertically between them, which gives the necessary strength and stiffness to this member.

From a study of the derrick with the boom in different positions it will be seen that this type of derrick has a greater reach for the same angular movement of the boom than the old type. Moreover, the load remains at approximately the same level, since the cross-beam tips down as the boom angle decreases, which is an obvious saving in work. With the ordinary type the longer the reach the greater the boom angle and the greater force required to move the boom; while in the new type all the work is done with boom angles of 45° and less. These features together with the increased safety should be much in its favor.

The derrick is easily converted into the standard type by disconnecting the rod links at the top, and folding down the balanced cross-beam until it forms an extension to the boom, where it may be clamped in place, giving the regulation figure 4 derrick, with an extra long boom. The new derrick is made in sizes having a reach of from 17 to 50 ft., and a drift of from 10 to 35 ft. The height of the mast differs from 20 to 55 ft., and the length of the boom from 16½ to 51½ ft.

This new type of derrick is patented, and is manufactured by the McVeigh-Dougherty Derrick Supply & Equipment Co., of Philadelphia, Pa.

Re-Surveys of City Lots.*

By A. E. DUCKHAM.†

In making the survey, after getting all available data from offices or records, either in City Hall or Court House, measure up the whole square or block, and ascertain whether there is a shortage or excess in it; and, if so, how much. Usually we find it to be the latter, as it was the custom of earlier days to give "good measure," as it was called, allowing an inch or two excess per chain length. Sometimes this was done to allow for errors in slope measurements, as the early surveyor seemed to dislike "breaking chain."

Some of our cities have what is called "City Measure": for example, the city of Pittsburgh allows an excess of 10 ft. per 100 ft.—thus in measuring 100 ft. "City," we would actually measure 100.10 ft. United States standard measure. This so-called "City Measure" was originally caused by a 25-ft. wooden pole, used as a standard in earlier days, which was 5/16-in. too long, making an error of 1¼ ins., or 0.10 ft. in 100 ft. This was discovered about 40 years ago, and the city officials passed a law perpetuating the mistake!

If any excess or shortage is found, it should, if possible, be divided pro rata among the lots of the plan. This rule will not always apply, however; for instance, the block may be all built solid with buildings, in which case we cannot disturb the houses which have been standing for many years (21 years of undisturbed possession giving them a legal tile, as long as the building remains standing); remembering the law, which is common sense, that the owners who built the houses probably had the original pins to build by; and it is not a question as to where the pins should have been, but of where they were placed by the original surveyor. Owners cannot be dispossessed of their property and made to move their houses at the caprice of any engineer following after. This rule our courts have well established for the good of the public.

Again the rule of pro rata applies only to a plan of lots. If the property has been sold off not as lots but by tracts, each man's deed calling for a certain distance from the corner of a street, then each man gets just what his deed calls for, and the last man who buys in that tract of land gets what is left, assuming the excess or shortage. Of course, he has recourse against the man who sold him a certain number of feet (providing he gets less than what he bought), although, if the deed says "more or less" he has no redress.

In no case can the engineer go out of the square in which he is working to make any adjustment. Each square must stand upon its own merits; and, if there is any error it must be adjusted in that square.

In a larger part of our older city districts there are no monuments or stones, and we have to make a complete survey of each and every house and lot in the square to determine to the best of our judgment where the original lines were; giving due credit to old pins, or marks on buildings, curb, cement, or stone walks.

Oak pins 1½ × 1½ × 16 ins. are usually set at corners (or on the 5-ft. "range line" on the sidewalk) in the suburban districts; while in the older, built-up parts of the city marks on the buildings, stone or cement sidewalks, and curb are the customary—crow-foot, or often a cross in the two latter places. A double crow-foot at a street corner on the face of the building indicates "right both ways."

As to plans, I use, as far as possible a standard size made on "onion-skin" paper, large business letter sheet size, and file them in letter files (book form) under the letter of the owner's name and the year. From these I make one or more blue prints which I furnish to the party having the survey made. At any time in the future he can have a blue print copy of same by applying for it. These plans are usually made on a scale of 20 or 30 ft. to an inch to show details of houses. All dimensions and distances off lot lines are given.

In addition to the above, the names of plan, number of lot, and where plan is recorded is given. The measure used (whether over or under U. S. Standard) is also indicated. The meridian is also placed on it. The street and lot bearings are taken from the old plans, as they are simply to determine the angle for the next engineer who has to make a survey, or for the use of the attorney or real estate man in drawing up the description of the deed.

Generally, in fact, almost always, the old bearings are unfortunately magnetic bearings. I say unfortunate, because though of little importance in city work, the true bearings would be of great service in work in country districts to give some idea by which we could search for the old corners. Not only that, but it would be more scientific, and we would not have the trouble of explaining to the attorneys such matters as the "variation of the needle," and why the magnetic bearings of the present are not the same as those of the past. It seems difficult for some of their "logical" minds to grasp it! I had difficulty once to explain to one of the "legal lights" (a great corporation lawyer) that northeast was not the same as southwest; he contended that there was no difference! "A man convinced against his will is of the same opinion still."

*Abstract from "The Cornell Civil Engineer," November, 1911.

†Consulting Engineer, 1213 House Bldg., Pittsburgh, Pa.

A Peculiar Steam Main Rupture and Method of Repairing It.*

By J. M. SMITH.†

Two years ago the University installed a steam line in a tunnel to connect the Agricultural Building with the Central Heating Station. This line is a 10-in. standard weight wrought-iron pipe, connected with forged steel screwed flanges and built for a working pressure of 125 lbs.

The line was put into service February, 1910, and, with the exception of a short shutdown in the summer of 1910, has operated continuously at a pressure of 120 lbs., till July, 1911, when it was shut off and some leaky gaskets were replaced. At this time, however, there was no leakage in the line aside from the gaskets. The steam was again turned on Sept. 25, at which time a split appeared in one length of pipe.

On examination it was found that the weld of the pipe had opened, starting just back of the flange and extending 4 ft. along the pipe. It was impossible to leave the steam off entirely until a new length of pipe could be obtained; so to prevent its opening further it was banded with four clamps of ½ × 4-in. iron.

The steam was then turned on. The clamps held against further opening, but the rupture leaked steam badly. It was decided to try welding the break with an autogeneous welding apparatus. The plan failed, however, because it was impossible to get the pipe hot enough in the tunnel to melt the iron. We also tried supplementing the torch with plumbers' furnaces, but this failed by excessive heating of the torch which caused back firing.

It was then decided to fill the groove with "Smooth-on" iron cement. This was put in, allowed to set over night, and a gasket of "Permanite" sheet packing 3 ins. wide was then placed over the patch. On this was placed a ½ × 2-in. iron extending the length of the rupture. It was then clamped with the ½ × 4-in. iron bands previously used. Steam was then turned on, and the pressure raised very slowly. The patch held the pressure perfectly, and has been in service for ten days without sign of leakage.

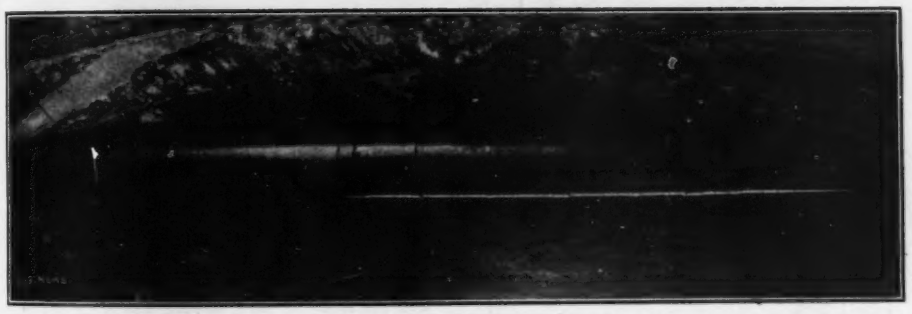
*From "The Wisconsin Engineer" of the University of Wisconsin.

†Chief Operating Engineer, University of Wisconsin.

A Unique Method of Repairing a Leaky Wrought-Iron Sewer Pipe.

By FREDERICK LATOURRETTE.*

Many times what seems to be a difficult problem to the engineer can be solved in a surprisingly simple manner, as the following case will illustrate. Our problem was the repair under difficult conditions of a 36-in. riveted pipe, of ⅜-in. wrought-iron, which had been in service for 35 years, to carry sewage under the floor of a bridge. Originally the pipe had been under the plank floor of a truss highway bridge, and had become deeply pitted by street droppings from overhead. Some time ago the bridge was replaced by a reinforced-concrete arch of 60-ft. span, into which a part of the pipe was built, the rest being exposed for a distance of about 50 ft. near the soffit of the arch. As a result of the pitting on the outside and the scour within, the pipe recently began to leak badly, and some means of repairing it cheaply and quickly became imperative.



REPAIR OF A 36-IN. RIVETED WROUGHT-IRON SEWER PIPE THROUGH THE SOFFIT OF A CONCRETE ARCH

The sewer above this point is on a considerable grade, so that the pipe often runs full and occasionally under some pressure. The pitting extended around the entire circumference, and leaks developed along the whole length of the bottom and for about one-third the distance up the sides. As the pipe was suspended over a street, and the sewage could not be diverted to another pipe, the situation called for prompt attention.

Plans and specifications were arranged for making repairs by leaving the old pipe in place and building another of 4 ins. larger diameter around it, filling the 2-in. space between with Portland cement grout. This method would have necessitated cutting away the arch ring around the pipe, inserting the covering pipe in semi-cylindrical sections, and replacing the arch ring with new concrete when the new pipe was in place. Only one bid was received for undertaking the work under this plan, and that bid (about $3,600) was out of all proportion to the necessary cost of the repairs, and was, moreover, a larger sum than the city had appropriated for the work. The case was further complicated by a city ordinance which forbids contracts in excess of $500 without requisite advertising; and advertising again would take time.

It was then that we hit upon the idea of using a patented iron cement known as "Smooth-On" iron cement, which is made by the Smooth-On Mfg. Co., of Jersey City. This cement had been previously used in some minor cases with complete success. The chief problem now was that this cement would not hold unless applied to a perfectly dry surface. Some way had to be devised for stopping the innumerable leaks.

This was accomplished by first removing all loose rust and scale. The leaks were then stopped by inserting dry wooden plugs, carefully whittled to fit the pits, some of which were nearly as large as the palm of the hand. With the patient application of many plugs and a liberal use of red lead and shellac most of the leaks were overcome. One particularly bad place was fixed by covering it with a piece of burlap which had been previously prepared with coatings of shellac and red lead. This was smoothed over the leaky area and held until the lead had set. All leaks were finally closed and a dry surface obtained. The entire surface of the pipe was then painted with a solution of "Smooth-On" cement No. 2, applied with a heavy paint brush. When this coat was dry a heavier covering of the same material was troweled on.

The concrete arch was cut away from the lower half of the pipe, so as to allow the semi-cylindrical plates which were used to cover the lower half of the pipe to enter 12 ins. into the soffit. These plates were 3/16-in. thick and about 10 ft. long, curved to a radius about 1 in. greater than the greatest outside radius of the pipe. The joints between the plates were made by butting the ends together and covering them with a 3/16 × 8-in. iron band which passed entirely around the pipe. Between the joints were two 3/16 × 4-in. bands which also bound the semi-cylindrical outside shell to the old pipe. The inner surfaces of the bands were carefully coated with soft cement before the bands were put in place.

The space between the shell and the pipe was then poured full of a mixture composed as follows:

Smooth-On concrete iron cement No. 7, 1 part by volume
Sharp sand.....1 part by volume
Dykerhoff Portland cement.....1 part by volume

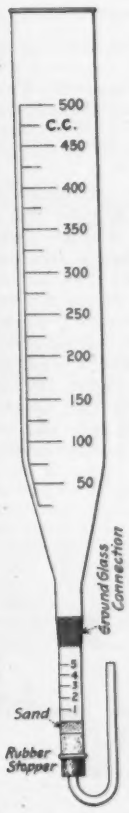
This space varied from 7/16-in. over the outside plates of the pipe to ⅞-in. over the inside plates. The top of the pipe was then plastered over with a coating of the same mixture applied with a trowel. When completed the pipe was as good as new at a cost of about $1,000. All work was done by city employees, and no single contract for material amounted to over $500. The accompanying illustrations show the work in progress and the completed job.

*Engineer of Construction, Street and Water Department, City Hall, Jersey City, N. J.

An Improved Sedgwick-Rafter Filter for Use in the Microscopical Examination of Water.

By S. T. POWELL.*

The Sedgwick-Rafter filter, for preparing samples of water for microscopical examination, has been in use for a number of years in the water laboratory. It is undoubtedly the most accurate and convenient method for quantitative analyses of algae and similar growths that has as yet been devised.† The filter consists of a cylindrical glass funnel, which is usually graduated and has a capacity of 500 c. c. In the lower end of the funnel is a perforated rubber stopper, upon which is placed a circle of silk bolting cloth, and which acts as a support for the filter sand.



The desired amount of water to be examined is placed in the funnel and filters through the sand, which retains the organisms. When the water is concentrated to 5 c. c., the rubber stopper is removed and the sand is washed with a small amount of distilled water to detach the organisms from the sand grains. One cubic centimeter of the concentrated liquid is then transferred to the counting cell and examined with the microscope.

Even with this apparatus, though, considerable error is apt to be made by the operator in transferring the concentrated water sample from the funnel to the counting cell previous to the examination of the organisms.

The writer has recently improved the funnel of this filter, as originally designed, and the use of the improved funnel in the laboratory under his charge has shown that the new design has considerable advantage over the old form. The improved funnel has a ground glass joint (see accompanying sketch) just above the 5 c. c. mark, so that when the desired concentration of the sample of water has been obtained the stem can be removed, and the concentrated water transferred to a dish or other receptacle. The rubber stopper can then be removed and the tube washed with a small amount of water, and this wash water added to the concentrated sample. It is readily seen that by removing the stem in this manner, there is much less chance of losing any of the sample than with the old form of funnel, which necessitated removing the rubber stopper. The organisms that adhere to the stem of the funnel during filtration can be much more easily removed from the detached stem with a small amount of water than is possible with the old-style funnel. The ground glass joint but slightly increases the cost of the apparatus.

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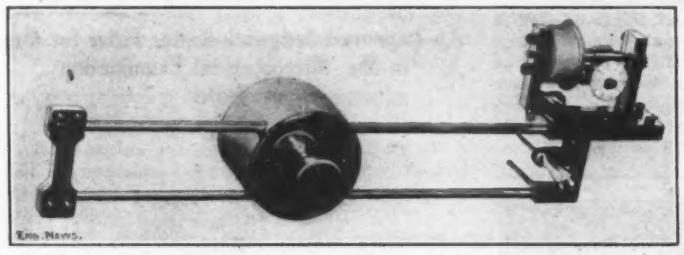
†See G. C. Whipple's "Microscopy of Drinking Water," for a more detailed description than is here given.

An Instrument for Averaging the Radii of Circular Diagrams.

The increasing use of circular-diagram instruments has given rise to a demand for some convenient method or instrument for readily determining the average reading. The essential features of an instrument for this purpose were described by its inventor, Prof. W. F. Durand, M. Am. Soc. M. E., in a paper published three years ago in the "Journal" of the American Society of Mechanical Engineers. The principles explained in that paper have been recently put into concrete form in the construction of what is



THE DURAND RADIAL AVERAGING INSTRUMENT.

known as the Durand radial planimeter. This is similar in principle to the Bristol-Durand instrument described in Engineering News June 30, 1910, p. 749, but is apparently of more convenient and compact design.

The Durand instrument consists essentially of a base pierced by two parallel guide holes and a pair of rods sliding side by side through these holes. The rods are connected rigidly together at each end by metal cross frames. To one of these cross frames are attached the tracing point and a pivoted carriage for the measuring wheel. The arrangement is such that the tracing point is guided by the sliding rods along a straight line passing through the center point of the base. At the same time the upper part of the base, through which the guide rods pass, can be rotated about the center. To use the instrument, the center point of its base is placed on the center of the diagram. Then, by a combination of the sliding and rotating motions, the tracing point can be made to follow the line of any circular diagram within its range.

The measuring wheel is mounted with its axis parallel to the guide rods and with its edge in a plane passing through the tracing point. Thus the wheel is not revolved by any radial motion of the point but responds to any angular motion about the center of the base, giving a record on its graduated scale proportional to the angular movement of the tracing point.

The measuring wheel is so graduated that the quotient thus obtained is the mean radial reading in inches. From this the average reading can be obtained in terms of the desired units by applying the appropriate scale factor.

This instrument is made in Switzerland by Amsler, Laffon & Co., and is put on the market in this country by Mr. W. L. Durand, 242 Lafayette Ave., Brooklyn, N. Y.

A Roof Shield for Steel Smokestacks.

While there is little danger to be expected from a new steel stack, in perfect condition, from the effect of heat radiated to nearby wood, unless the stack is in actual contact with the wood, there is danger after the stack is old and has become corroded by the action of the hot acid products of combustion. There is always a considerable difference in temperature below and above the boiler room roof, which causes a condensation of the acid products of combustion, especially of the pyroligneous and acetic products, at the place where the stack passes out of the roof. These hot acids will eventually corrode the stack sufficiently to cause holes and thereby endanger the adjoining woodwork.

Two designs for a shield to protect the woodwork of the roof are given in the October Quarterly of the National Fire Protection Association, and are said to give very satisfactory service. These designs are shown by the accompanying illustration.

It is stated that the tendency of the smoke and gases is to pass up the stack in a centrifugal course, seeking an outlet, and a spark will soon find even a minute hole through which it may lodge on the nearby woodwork. The effect of the collar and umbrella, shown in Figs. 1 and 2, is to form an air space of equal temperature at the roof line, through which the air from below can readily pass out, thus reducing the liability of condensation in the stack at or near this place. The collar is extended below the roof line sufficiently to protect the roof timbers against the lodgment of sparks. For stacks of wood-burning or direct-oflue boilers, where the stacks are hot, the double collar and umbrella arrangement shown in Fig. 2 is best.

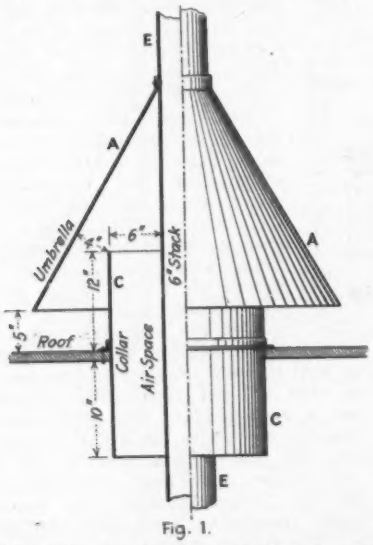


Fig. 1.

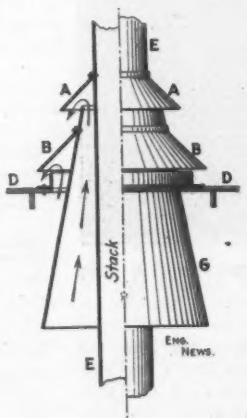


Fig. 2.

GALVANIZED IRON ROOF SHIELDS AROUND STEEL SMOKESTACKS.

The material to be used is galvanized iron, not less than No. 18 (American) gage. The diameter of the collar should be at least three times the diameter of the stack when the stack is 6 ins. or less in diameter, and at least 12 ins. greater than the diameter of the stack when its diameter exceeds 6 ins. The lower edge of the collar must come at least to the bottom of the nearest rafters or purlins. The angle of flare of the umbrella is optional; about 60° is said to be satisfactory. The accompanying table shows the principal dimensions for the smaller stacks.

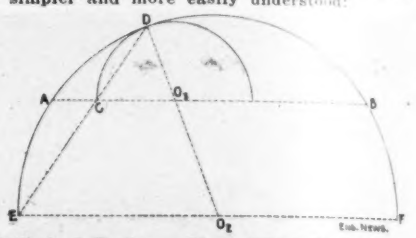
Diam. of Stack.	Diam. of Collar.	Distance Above Top of Collar to Umbrella.	Height of Collar Above Roof Line.	Distance from Roof (Highest Part) to Bottom of Umbrella.
3 ins.	9 ins.	3 ins.	5 ins.	3 ins.
4 ins.	12 ins.	4 ins.	7 ins.	3 ins.
5 ins.	15 ins.	4 ins.	8 ins.	4 ins.
6 ins. or more	18 ins. or more	4 ins. or more	9 ins. or more	5 ins. or more

From studies of the statistics of the National Fire Protection Association of fires in steam-operated electric light and power plants, it has been determined that no less than one-third such fires have originated in defective smokestack protection.

Notes.

Stadia Tape.—Referring to the description of a cheap and convenient stadia rod by Mr. W. Newbrough in our issue of Nov. 23, Mr. Emile Low, Buffalo, N. Y., states that many rods made with paper scales are in use by the engineering department of the New York State Barge Canal. They use strips of various widths graduated to feet, tenths and hundredths, in lengths of 12 ft. Most of the dealers in engineers' supplies and instruments advertise level rod tape of this character. We do not recall advertisements of stadia tape.

Another Solution of the Problem given in our last Field and Office issue, Nov. 23, p. 627, Fig. 2, is sent to us by Mr. R. H. Bullock, of Wilmington, N. C. He suggests that the following construction (shown in the accompanying figure) is simpler and more easily understood:



Method of Finding a Circle Which Shall Have Its Center On, and Pass Through a Given Point on, a Given Chord, and Be Tangent to the Circle of the Given Chord.

Draw the diameter of the given arc EF, parallel to the given chord AB; draw the line EC through the given point C, and produce it to its intersection with the given circle at D. The center of the circle sought is the point of intersection of the chord AB and the radius O_2D; from the similarity of triangles $O_2D = O_2C$ because $O_2D = O_2E$.

Topography Methods.—The description of a topographical survey of an English estate, in our issue of Nov. 23, 1911, is discussed by a Western engineer as follows:

Whether your article, "An English Topographical Survey" was printed as an illustration of current English practice or simply as an illustration of "how it may be done," I cannot tell, but it certainly is a fearful and marvelous piece of work. The last paragraph notes that, in addition to the triangulation system, 200 miles of traverse were run and 50 miles of contours. There certainly were more than 50 miles of contours on his map, else why didn't he traverse his contours and let it go at that, saving about three-fourths of his work. In these parts we can run ditch lines at 2.5 miles a day, except in the most mountainous parts.

Americans, I imagine, are more prone to survey with an eye single to the resulting utility rather than to strive for an unattainable exactness. If an instrument man would propose the establishment of a complicated system of triangles for such a survey as this, I would suspect him of having had too much book learning. On the basis of a rectangle 3 x 4 miles, 35 miles of traverse would have placed points within ½ mile of each other. Using a 300-ft. tape, measuring on the slope with vertical angles, and a mountain transit reading to minutes, closures of 1 in 4,000 may be obtained regularly at a speed of four miles a day (except in most precipitous country). The longest leg of such a traverse would be four miles, the maximum error at 1:4000 is 5 ft., amounting at a scale of 132 ft. per in., to 0.04 in. The balanced position of such a point would be correct to less than half this amount, but even the maximum error of plotting (0.04 in.) I would judge to be ample for any use to which such a map could be put. Excluding reconnaissance, I would give a party of four men 10 days at most to get ready for the stadia survey.

The stadia with transit would be tied in to the traverse points by short closed lines read by stadia. The field party would be: 1 rodman, 1 sketcher, 1 instrument man, the latter two to take turns at the instrument. A fourth man as mapper would be needed to work up and plot the

notes. The roughest and worst piece of ground I have contoured in the years past was taken for 10-ft. contours and a scale of 100 ft. per in., for industrial development, using the methods as outlined. The complete field work proceeded at an average of 39 acres per day of eight hours. This speed has been equaled many times in my experience, and I would judge it a very good rate for country sloping up to 10% and more or less cut up by ravines, etc., which, by the way, is unusually rough country for such work.

If I were asked to estimate the cost of contouring 5,000 acres of "rough" ground for industrial development, for a map of 100 ft. per in. and 10-ft. contours, the following would be my figures:

TIME ESTIMATE, days work.

	Chief.	Instr't.	Mapper.	Assis't.
Reconnaissance	2			
Traverse	10	10	10	10
Contouring	120	120	120	120
Bad weather	15	15	15	15
Transportation	2	2	2	2
Total	149	147	147	147

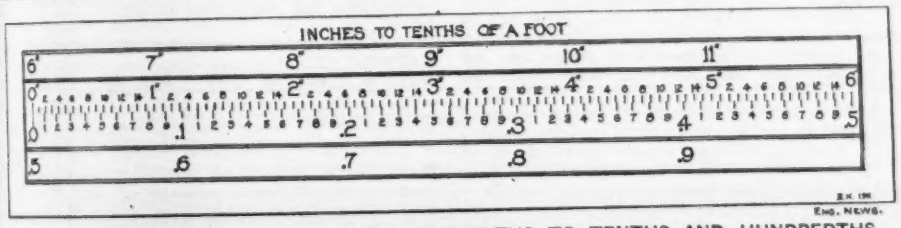
COST ESTIMATE.

Salaries:		
Chief, 149 days	$5.00	$745.00
Instrument, 147 days	4.00	588.00
Mapper, 147 days	3.50	514.50
Assistant, 147 days	2.50	367.50
Subsistence: 550 days	1.00	550.00
Total cost (excluding transportation to site of survey)		$2,765.00
		or 0.55 per acre.

This would represent the very worst open country I would ordinarily expect to get. On flat country, the cost should run down to $0.15 an acre for prairie land, and I feel that the resulting map would be sufficient for every purpose.

E. E. Thum, Engr.,
Anaconda Copper Mining Company, Great Falls, Mont.

A Converting Scale Reducing Inches to Feet is suggested by Mr. Edward Kromer, 415 Linwood Ave., Columbus, Ohio, to take the place of tables. The advantages claimed for the scale over tables are compactness and rapidity. The scale is laid out with parallel graduations — inches and sixteenths above, and tenths of feet and hundredths below. Readings can be made directly



SCALE FOR CONVERTING INCHES AND SIXTEENTHS TO TENTHS AND HUNDREDTHS OF A FOOT.

to the nearest sixteenth of an inch or hundredth of a foot, which is sufficiently close for most field practice such as that encountered in railway construction work. Additional compactness is secured by superposing the latter half of the scale, from 6 to 12 ins., above the first half as shown in the illustration herewith.

Reinforcement Around Openings in Reinforced-Concrete Slabs.—In further discussion of the above subject which was taken up in our issues of Oct. 19 and Nov. 23, 1911, Mr. Stewart G. Collins, of Duluth, Minn., writes:

I beg to submit that it is not the invariable habit of either designers or builders to double the steel as shown in Engineering News, Nov. 23, 1911, on p. 628, on either side of the holes in concrete floors. The writer can show Mr. McCullough plans of several hundred buildings now completed in which the method advocated by Mr. Godfrey was used.

One great handicap which reinforced concrete has had is the tendency of designers to think in terms of wood construction, and to consider that the mere arrangement of the rods in imitation of joist construction locates the stresses to correspond. The fact that the "old carpenter" could not arrange his joist any other way does not force this method on concrete designers. This theory is in line with that of many builders and laymen that the strength of a floor can be increased indefinitely by mere increase in the number of rods.

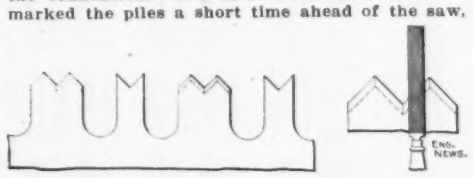
The statement that a designer who is competent to design a reinforced-concrete structure is competent to design the arrangement around a hole, is equivalent to stating that no competent designer ever makes a mistake or an error in judgment, and leads one round in a circle. As to "inartistic" placing of steel, the writer has seen some very nicely executed and artistic designs which were decidedly unsafe. More common sense and less art is needed in reinforced concrete.

The sheep-like imitation in concrete of wood construction would never have produced the two-way slab or the cantilever flat slab construction, which is one of the greatest steps forward in recent years, and let us hope for the sake of the art that reinforced-concrete designers will soon forget the "old carpenter" who doubled his joists whether the hole was four feet or ten feet wide.

A Rapid Pile Cutting Job is described by Mr. H. K. Higgins, of Portland, in the following letter:

A piled chimney foundation in southern New England used 167 piles of local chestnut and oak, some 90% being white and red oak. All piles were green timber. The driving was very hard, leaving from 1 to 3 ft. of pile to be cut off.

Two of the piledriving gang took the job of cutting the piles on a piece-work basis. They cut the 167 piles to grade in 6 hrs. 25 mins. actual working time, averaging about 2¼ mins. per pile. The piles averaged 9 ins. diameter at the end cut. Grades were given at four points, the corners of the foundation. The cutters leveled across and marked the piles a short time ahead of the saw,



Sketch of Saw Teeth and Position of File.

one using the carpenter's level while the other filed the saw. Several individual saw cuts were timed in from 50 to 56 seconds, net cutting time, in about two half minute periods with a 10-sec. rest between. One oak pile 10¼ ins. diameter required 54 secs.

The secret of the speed of the job seemed to lie in hard work, frequent rest and the use of a very sharp saw. In filing the saw the file was held square to the edge, without rake forward or back. The saw was not a specially good one, so the men said. It was about 3 ins. wide and had some 3 ins. crown. The teeth were alternately cross-cut and chisel-point, in pairs, as shown by the adjoining sketch. They were set rather wide. Care was taken to keep the cross-cut teeth a very little longer than the chisel-point teeth. The time taken up in filing was rather irregular, but it was in no case a large fraction of the sawing time.

The net sawing time was about 40% of the elapsed time. It was evident that the men worked very hard while sawing and rested till able to resume the pace. The day was hot, July 17, there was little breeze and the men were nearly tired out at completion.

Rapid Blueprint Paper.—A correspondent asks for information about a method of quickening and retarding the time of printing blue prints by variations of the formula for sensitizing chemicals. He uses two ounces of ferric ammonium citrate to one ounce of ferricyanide of potassium and 20 ounces of water. Paper treated with this solution requires from eight to fifteen minutes to get a good print, and a paper is desired which will print in from two to three minutes in winter.

In Engineering News, Dec. 15, 1892, p. 569, the formulas found successful by Mr. F. H. Latimer, of Vancouver, B. C., were reprinted. He first added a few drops of strong ammonia to the solution of ferric ammonium citrate, until the odor of ammonia was marked. Then various amounts of a saturated solution of oxalic acid were added to the combined ferric ammonium citrate and ferricyanide solutions.

By the addition of 1, 2 or 3 oz. of the oxalic acid solution to 10 oz. of sensitizing fluid, the time of printing was reduced 2½, 5 and 10 times. It was found difficult to secure good whites, however, with more than 2 oz. in 10. Moreover, this great difference in time of printing held only for cloudy weather and not for direct sunlight, the gains being then about one-third those noted.

It was reported at that time that ferric oxalate and potassium ferricyanide mixed made a very rapid paper, but too sensitive for ordinary work and requiring more care than that ordinarily given to engineering prints.

Hints for the Surveyor's Office.—The following hints, from W. Newbrough, Evanston, Wyo., are not claimed as new or original, but they have proved their utility during some years and they may interest others:

RUNNING LEVELS WITH A TRANSIT.—When running rather long lines of levels with a transit it will facilitate matters if the screws on the top of the standards are screwed down rather tight. Then practically all the leveling can be done with the base screws. When through, loosen the standard screws again, as this method is a little liable to be hard on the instrument.

TO PREPARE TRACING CLOTH.—Instead of using pumice, or chalk, or talcum powder, use a piece of ordinary blotting paper and rub hard over the surface. This is much cleaner than the foregoing methods.

BLUEPRINTS.—To obtain intense blue with white lines, or to save blueprints which have been overexposed: Overexpose the print, allow to dry until the surplus water has drained off, then go over the print with a sponge saturated with hydrogen peroxide; dip the print again in water for a minute and hang up to dry. This method will not work unless the print has been overexposed in the first place. A trial or two will show how much to overexpose.

A Simple Method of Determining Azimuth for finding the declination of a compass is as follows: On the south edge of a level table or other similar surface erect an upright 18 to 24 ins. high with a piece of opaque paper or tin fixed horizontally to the top, or making an acute angle to the vertical. Prick a small hole through the paper or tin. The table is so placed that the sun will shine on it for about ½ an hour before and after noon. On a piece of drawing paper previously placed on the table mark the position of the sun spot, caused by the sun shining through the pinhole, at intervals of say 10 mins. Connect these spots to form a smooth curve. From a point on the table vertically below the pinhole as a center draw the arc of a circle intersecting the first curve in two points. Then by the ordinary method of intersecting arcs erect a perpendicular midway between these points, which of course will pass through the center of the arc. This line gives an azimuth with which compasses may be compared with accuracy sufficient for general purposes. (From the Engineer Field Manual, U. S. Army.)

Horizontal Distances and Elevations From Stadia Readings: 31°-45.°

Probably most engineers and surveyors are familiar with the stadia tables published in the various text-books on surveying, covering vertical angles from 0° to 30°, as for example those given in the Appendix of Johnson's "Theory and Practice of Surveying" as Table V. The original of these tables was computed by Mr. Arthur Winslow, M. Am. Inst. M. E., for the Second Geological Survey of Pennsylvania, 1874-1887.

The advantage of extending the tables to cover vertical angles to 45° has doubtless been seen by many surveyors engaged in stadia surveys in hilly country. The table on our next page was computed by Mr. Howard N. Eavenson, M. Am. Soc. C. E., Chief Engineer of the United States Steel & Coke Co., of Pittsburgh, Pa., for use in stadia surveys in the mountains of West Virginia about 20 years ago, and has at various times proved so useful that he believes it will find a welcome among engineers and surveyors generally.

To use the table, multiply the rod reading by the table value for the observed vertical angle and add the constant c for the given value of $f + c$, f being the focal length of the objective lens, and c the distance from the objective to the center of the instrument. Thus if the rod reading were 5 ft., the vertical angle, 33° 20′, and $f + c = 1.0$, we would have:

$$5.0 \times 69.80 + 0.84 = 349.84 \text{ Hor. Dis.}$$
$$5.0 \times 45.91 + 0.54 = 230.09 \text{ Diff. Elv.}$$

A Pumping and Irrigation Chart.

By S. N. ARNOLD.*

The accompanying chart was developed by the writer to facilitate calculations for a pumping and irrigation project in hand and so many requests for copies have been received from engineers and others interested in irrigation that it was believed the chart might be useful to the readers of Engineering News.

The main curves represent constant values of acre-feet and horsepower for different arrangements of coordinates. Thus the abscissas represent depth and duration of irrigation, horsepower, and height of lift. The primary ordinates represent acres and cubic feet per second.

The curves represent graphically three formulas in each of which the coordinates vary inversely as each other, so that it is only necessary to properly proportion the scales to make one set of curves serve all three.

The formulas are:

$$\text{Acre-feet} = D\,N \qquad (1)$$

$$\text{" "} = \frac{F\,t}{43{,}560} \qquad (2)$$

$$\text{Horsepower} = \frac{62.5\,F\,H}{550} \qquad (3)$$

Where

D = depth of irrigation in feet.
N = number of acres irrigated.
F = flow in cubic feet per second.
t = time of flow in seconds.
H = height of lift in feet.

The curves were first plotted with values of N as ordinates and values of D (subdivided into inches) as abscissas. Since the maximum number of acres taken is 240 the acre-feet value of each curve will be

$$240\,D = \frac{240}{12}\,d = 20\,d$$

where d = inches depth of irrigation. Then the successive points of a curve would be plotted from (1) rewritten as

$$d = \frac{12 \times \text{acre-feet}}{N}.$$

If we let T = time in 24-hour days, then

$$T = \frac{t}{60 \times 60 \times 24}, \text{ or } t = 86{,}400\,T.$$

Substituting this value in (2) and equating with (1) we have

$$D\,N = \frac{86{,}400}{43{,}560}\,F\,T = \frac{240}{121}\,T\,F.$$

Whence

$$\frac{D\,N}{T\,F} = \frac{240}{121} \qquad (4)$$

We may use the same curves to show the interrelation of both quantities if we properly replace depth by time and acres by flow. If we give T and D of (4) the same value this formula becomes

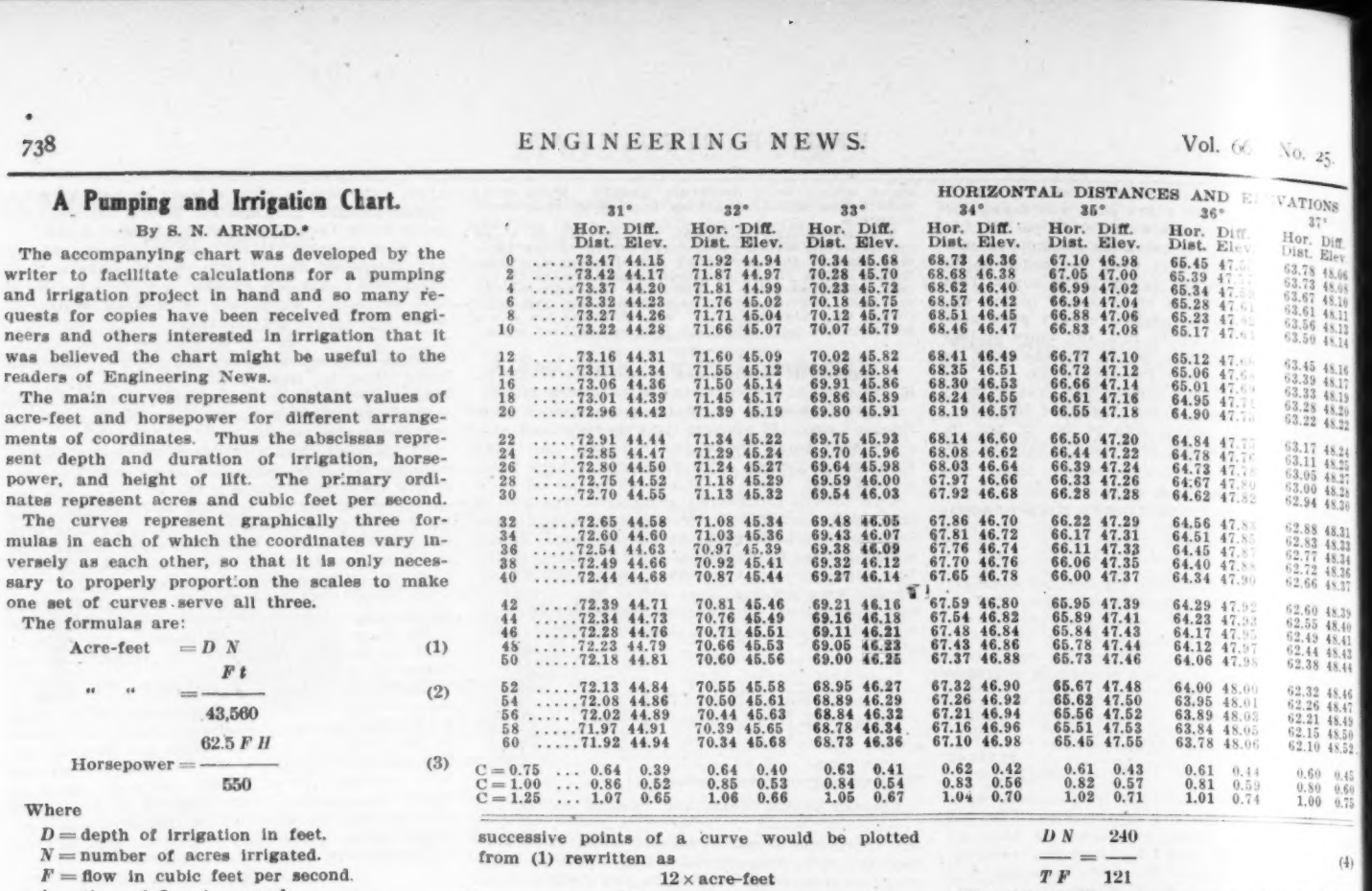
$$\frac{N}{F} = \frac{240}{121}.$$

Therefore the length of scale representing 240 acres for the curve of formula (1) must be divided into 121 parts to represent as ordinates the cubic feet per second of (2).

*The Dalles, Oregon.

HORIZONTAL DISTANCES AND ELEVATIONS

'	31° Hor. Dist.	31° Diff. Elev.	32° Hor. Dist.	32° Diff. Elev.	33° Hor. Dist.	33° Diff. Elev.	34° Hor. Dist.	34° Diff. Elev.	35° Hor. Dist.	35° Diff. Elev.	36° Hor. Dist.	36° Diff. Elev.	37° Hor. Dist.	37° Diff. Elev.
0	73.47	44.15	71.92	44.94	70.34	45.68	68.73	46.36	67.10	46.98	65.45	47.5[illegible]	63.78	48.06
2	73.42	44.17	71.87	44.97	70.28	45.70	68.68	46.38	67.05	47.00	65.39	47.5[illegible]	63.73	48.08
4	73.37	44.20	71.81	44.99	70.23	45.72	68.62	46.40	66.99	47.02	65.34	47.58	63.67	48.10
6	73.32	44.23	71.76	45.02	70.18	45.75	68.57	46.42	66.94	47.04	65.28	47.61	63.61	48.11
8	73.27	44.26	71.71	45.04	70.12	45.77	68.51	46.45	66.88	47.06	65.23	47.62	63.56	48.13
10	73.22	44.28	71.66	45.07	70.07	45.79	68.46	46.47	66.83	47.08	65.17	47.64	63.50	48.14
12	73.16	44.31	71.60	45.09	70.02	45.82	68.41	46.49	66.77	47.10	65.12	47.66	63.45	48.16
14	73.11	44.34	71.55	45.12	69.96	45.84	68.35	46.51	66.72	47.12	65.06	47.68	63.39	48.17
16	73.06	44.36	71.50	45.14	69.91	45.86	68.30	46.53	66.66	47.14	65.01	47.69	63.33	48.19
18	73.01	44.39	71.45	45.17	69.86	45.89	68.24	46.55	66.61	47.16	64.95	47.71	63.28	48.20
20	72.96	44.42	71.39	45.19	69.80	45.91	68.19	46.57	66.55	47.18	64.90	47.73	63.22	48.22
22	72.91	44.44	71.34	45.22	69.75	45.93	68.14	46.60	66.50	47.20	64.84	47.77	63.17	48.24
24	72.85	44.47	71.29	45.24	69.70	45.96	68.08	46.62	66.44	47.22	64.78	47.76	63.11	48.25
26	72.80	44.50	71.24	45.27	69.64	45.98	68.03	46.64	66.39	47.24	64.73	47.78	63.05	48.27
28	72.75	44.52	71.18	45.29	69.59	46.00	67.97	46.66	66.33	47.26	64.67	47.80	63.00	48.28
30	72.70	44.55	71.13	45.32	69.54	46.03	67.92	46.68	66.28	47.28	64.62	47.82	62.94	48.30
32	72.65	44.58	71.08	45.34	69.48	46.05	67.86	46.70	66.22	47.29	64.56	47.83	62.88	48.31
34	72.60	44.60	71.03	45.36	69.43	46.07	67.81	46.72	66.17	47.31	64.51	47.85	62.83	48.33
36	72.54	44.63	70.97	45.39	69.38	46.09	67.76	46.74	66.11	47.33	64.45	47.87	62.77	48.34
38	72.49	44.66	70.92	45.41	69.32	46.12	67.70	46.76	66.06	47.35	64.40	47.88	62.72	48.36
40	72.44	44.68	70.87	45.44	69.27	46.14	67.65	46.78	66.00	47.37	64.34	47.90	62.66	48.37
42	72.39	44.71	70.81	45.46	69.21	46.16	67.59	46.80	65.95	47.39	64.29	47.92	62.60	48.39
44	72.34	44.73	70.76	45.49	69.16	46.18	67.54	46.82	65.89	47.41	64.23	47.93	62.55	48.40
46	72.28	44.76	70.71	45.51	69.11	46.21	67.48	46.84	65.84	47.43	64.17	47.95	62.49	48.41
48	72.23	44.79	70.66	45.53	69.05	46.23	67.43	46.86	65.78	47.44	64.12	47.97	62.44	48.43
50	72.18	44.81	70.60	45.56	69.00	46.25	67.37	46.88	65.73	47.46	64.06	47.98	62.38	48.44
52	72.13	44.84	70.55	45.58	68.95	46.27	67.32	46.90	65.67	47.48	64.00	48.00	62.32	48.46
54	72.08	44.86	70.50	45.61	68.89	46.29	67.26	46.92	65.62	47.50	63.95	48.01	62.26	48.47
56	72.02	44.89	70.44	45.63	68.84	46.32	67.21	46.94	65.56	47.52	63.89	48.03	62.21	48.49
58	71.97	44.91	70.39	45.65	68.78	46.34	67.16	46.96	65.51	47.53	63.84	48.05	62.15	48.50
60	71.92	44.94	70.34	45.68	68.73	46.36	67.10	46.98	65.45	47.55	63.78	48.06	62.10	48.52
C = 0.75	0.64	0.39	0.64	0.40	0.63	0.41	0.62	0.42	0.61	0.43	0.61	0.44	0.60	0.45
C = 1.00	0.86	0.52	0.85	0.53	0.84	0.54	0.83	0.56	0.82	0.57	0.81	0.59	0.80	0.60
C = 1.25	1.07	0.65	1.06	0.66	1.05	0.67	1.04	0.70	1.02	0.71	1.01	0.74	1.00	0.75


Depth of Irrigation in Inches and Height of Lift in Feet.
% Efficiency
Flow in Cubic Feet per Second δ=1.0083
Horse Power of Curves.
Time of Flow in Hours δ=2.
Period of Flow in Days of 24 Hours.
Acre Feet δ=20 (Refers to Curves.)
No. of Acres δ=1
Curves
Acre Feet δ=20
Horse Power δ=13.75

A PUMPING AND IRRIGATION CHART, SHOWING CURVES OF FLOW AND HORSEPOWER.

FROM STADIA READINGS: 31°-45°.

	38°		39°		40°		41°		42°		43°		44°	
	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.	Hor. Dist.	Diff. Elev.
0	62.10	48.52	60.40	48.91	58.68	49.24	56.96	49.51	55.23	49.73	53.49	49.88	51.74	49.97
2	62.04	48.53	60.34	48.92	58.63	49.25	56.90	49.52	55.17	49.73	53.43	49.88	51.69	49.97
4	61.98	48.54	60.28	48.93	58.57	49.26	56.84	49.53	55.11	49.74	53.37	49.89	51.63	49.97
6	61.93	48.56	60.23	48.94	58.51	49.27	56.79	49.54	55.05	49.74	53.31	49.89	51.57	49.98
8	61.87	48.57	60.17	48.96	58.45	49.28	56.73	49.55	55.00	49.75	53.25	49.89	51.51	49.98
10	61.81	48.58	60.11	48.97	58.40	49.29	56.67	49.55	54.94	49.76	53.20	49.90	51.45	49.98
12	61.76	48.60	60.05	48.98	58.34	49.30	56.61	49.56	54.88	49.76	53.14	49.90	51.40	49.98
14	61.70	48.61	60.00	48.99	58.28	49.31	56.56	49.57	54.82	49.77	53.08	49.90	51.34	49.98
16	61.64	48.63	59.94	49.00	58.22	49.32	56.50	49.58	54.76	49.77	53.02	49.91	51.28	49.98
18	61.59	48.64	59.88	49.01	58.17	49.33	56.44	49.58	54.71	49.78	52.96	49.91	51.22	49.99
20	61.53	48.65	59.83	49.02	58.11	49.34	56.38	49.59	54.65	49.78	52.91	49.92	51.16	49.99
22	61.47	48.67	59.77	49.04	58.05	49.35	56.33	49.60	54.59	49.79	52.85	49.92	51.10	49.99
24	61.42	48.68	59.71	49.05	57.99	49.36	56.27	49.61	54.53	49.79	52.79	49.92	51.05	49.99
26	61.36	48.69	59.65	49.06	57.94	49.37	56.21	49.61	54.47	49.80	52.73	49.93	50.99	49.99
28	61.30	48.71	59.60	49.07	57.88	49.38	56.15	49.62	54.42	49.80	52.67	49.93	50.93	49.99
30	61.25	48.72	59.54	49.08	57.82	49.38	56.09	49.63	54.36	49.81	52.62	49.93	50.87	49.99
32	61.19	48.73	59.48	49.09	57.76	49.39	56.04	49.63	54.30	49.81	52.56	49.93	50.81	49.99
34	61.13	48.74	59.43	49.10	57.71	49.40	55.98	49.64	54.24	49.82	52.50	49.94	50.76	49.99
36	61.08	48.76	59.37	49.11	57.65	49.41	55.92	49.65	54.18	49.82	52.44	49.94	50.70	50.00
38	61.02	48.77	59.31	49.12	57.59	49.42	55.86	49.66	54.13	49.83	52.38	49.94	50.64	50.00
40	60.96	48.78	59.25	49.14	57.53	49.43	55.81	49.66	54.07	49.83	52.33	49.95	50.58	50.00
42	60.91	48.80	59.20	49.15	57.48	49.44	55.75	49.67	54.01	49.84	52.27	49.95	50.52	50.00
44	60.85	48.81	59.14	49.16	57.42	49.45	55.69	49.68	53.95	49.84	52.21	49.95	50.47	50.00
46	60.79	48.82	59.08	49.17	57.36	49.46	55.63	49.68	53.89	49.85	52.15	49.95	50.41	50.00
48	60.74	48.83	59.03	49.18	57.30	49.46	55.57	49.69	53.84	49.85	52.09	49.96	50.35	50.00
50	60.68	48.85	58.97	49.19	57.25	49.47	55.52	49.69	53.78	49.86	52.04	49.96	50.29	50.00
52	60.62	48.86	58.91	49.20	57.19	49.48	55.46	49.70	53.72	49.86	51.98	49.96	50.23	50.00
54	60.57	48.87	58.85	49.21	57.13	49.49	55.40	49.71	53.66	49.87	51.92	49.96	50.17	50.00
56	60.51	48.88	58.80	49.22	57.07	49.50	55.34	49.71	53.60	49.87	51.86	49.97	50.12	50.00
58	60.45	48.90	58.74	49.23	57.02	49.51	55.28	49.72	53.55	49.87	51.80	49.97	50.06	50.00
60	60.40	48.91	58.68	49.24	56.96	49.51	55.23	49.73	53.49	49.88	51.74	49.97	50.00	50.00
C=0.75	0.59	0.46	0.58	0.47	0.57	0.48	0.57	0.49	0.55	0.50	0.55	0.51	0.54	0.52
C=1.00	0.79	0.62	0.78	0.63	0.77	0.64	0.75	0.66	0.74	0.67	0.73	0.68	0.72	0.68
C=1.25	0.98	0.78	0.97	0.79	0.96	0.80	0.94	0.82	0.92	0.84	0.91	0.85	0.90	0.86

The horsepower abscissas are added for convenience in determining the power required to deliver a given flow to any height. Give each division of the horizontal scale a value of 5 ft. lift and compute the horsepower of all curves for 121 cu. ft. per sec. and 1 ft. lift as a matter of convenience. From (3) the horsepower of the first curve starting from the 121 cu. ft. per sec. line is

$$\text{HP.} = \frac{62.5 \times 121 \times 1}{550} = 13.75.$$

The horsepower of the second curve is of course twice that or 27.50 and so on with an increment of 13.75 HP. between curves. To facilitate use of the curves the scale of abscissas is raised to a point where one space represents 25 HP. This of course, is where the first curve computed is 0.55 spaces from zero. Any point on the scale shown gives the constant value of horsepower for the curve passing through that point.

The efficiency curves at the top of the chart are applicable to any one of the abscissa scales, and have been derived by dividing each height by 0.9, 0.8, 0.7 and 0.6 to find the theoretical value at 90%, 80%, 70% and 60% efficiency, respectively. Thus to lift a given flow 60 ft. at 100% is equivalent to 60/0.8 = 75 ft. at 80%. The horsepower needed is that of the curve passing through the intersection 75 ft. and the given flow. This last process is accomplished without computation by reading the abscissa (60 ft. for instance) on the 100% line and following the curves upward to the 80% line to find the desired value (75 ft. in this case).

These curves can also be used for ditch efficiency; if it is desired to irrigate a piece of land to a depth of 12 ins. and the efficiency of the ditches delivering the water is 80%, enough water must be delivered to the ditch to cover the lands 12/0-8 = 15 ins. deep and calculations of flow must be made on that basis.

EXAMPLES SHOWING USE.

EXAMPLE 1.—With a water right of 3 cu. ft. per sec. how much land can be irrigated 18 ins. deep in a season of 120 days?

Solution: Find the intersection of the 12-day and 30-cu. ft. per sec. lines. Follow the curve that passes through this point (720 acre ft.) to its intersection with the 18-in. depth line. As it does not cross the 18-in. depth line follow it to the 180-in. depth line and read 48 acres on the right-hand scale. Answer, 480 acres.

EXAMPLE 2.—Suppose an efficiency of 70% for new ditches in Example 1, how many acres should be put under the first year to insure 18 ins. of irrigation?

Solution: Take any of the efficiency curves at the top of the chart as, for instance, the one starting at 60-ft. lift. Find the intersection of the 60-ft. and 48-acre lines. A certain curve passes through this point. From the 70% point on the same efficiency curve drop a perpendicular to the same curve and read 33.6 acres on the right hand scale. Transpose the 48 and 33.6 back to 480 and 336 acres.

EXAMPLE 3.—How many cubic feet per second are required to irrigate 160 acres 3 ins. deep in 48 hours?

Solution: The horizontal line of 160 acres intersects the vertical line of 3-ins. depth at a point on the 40-acre ft. curve. Follow this curve until it intersects the 48-hr. vertical and read the answer 10.083 cu. ft. per sec. on the left-hand scale.

EXAMPLE 4.—How many acres will 5 cu. ft. per sec. irrigate to a depth of 6 ins. in 30 days?

Solution: The 50-cu. ft. per sec. horizontal intersects the 3-day vertical on the 300-acre ft. curve. This curve does not cross the 6-in. line so we follow it around to the 60-in. line and read 60 acres on the right-hand scale; changing the decimal, the answer is 600 acres.

Note.—(In the above we used the 50.417 cu. sec. ft. horizontal as 50 cu. sec. ft., an error of 0.833%, hence to obtain a correct answer we must divide 600 by 1.00833; equals 595 acres. For ordinary purposes, however, the nearest even division will give sufficiently accurate answers.)

EXAMPLE 5.—How long will it take to cover 40 acres 8 ins. deep having a flow of 2 cu. ft. per sec?

Solution: Find the intersection of 40 acres and 8 ins. depth; follow the curve passing through this point to where it crosses the 2-cu. ft. per sec. line and read 10 days or 240 hrs. on the lower scale.

EXAMPLE 6.—What theoretical horsepower is required to raise 6 cu. ft. per sec. of water to a height of 80 ft.?

Solution: Find the intersection of the 6 cu. ft. per sec. and the 80-ft. lift lines. A curve passes through this point which followed around to the HP. scale is found to be 55-HP. By using the 60.5-cu. ft. per sec. line we have a better defined crossing with the 80-ft. vertical on the 550-HP. curve.

EXAMPLE 7.—How many HP. would be required in Example 6, assuming 80% efficiency?

Solution: Follow the efficiency curve at the top of the chart from 80 ft. lift; this curve crosses 80% efficiency at 100 ft. Reading down this vertical to its intersection with the 60.5-cu. ft. per sec. line we find that it will require 68.75 HP.

EXAMPLE 8.—How many horsepower will be required in Example 6 at 60% efficiency?

Solution: Following the same efficiency curve around to 60% and projecting down to the 60.5-cu. ft. per sec. horizontal we find the intersection lies between the 90.75 and the 93.5-HP. curves, being about one-third the distance from the former or 91.67 HP.

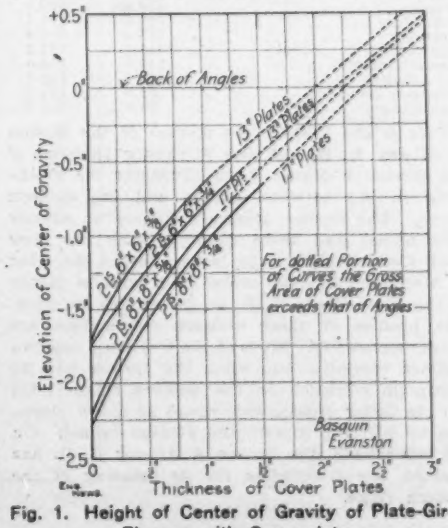


Fig. 1. Height of Center of Gravity of Plate-Girder Flanges with Cover-plates.

Two Girder Diagrams.

The two diagrams reproduced herewith will prove handy to structural designers. Their construction is simple but they will save much time in computation.

The diagram Fig. 1 gives the position of center of gravity of the flange of a plate-girder with cover-plates. The diagram is self-explanatory. It can be extended to include other sizes of the more common angles used in this way, with their appropriate sizes of cover-plates; to avoid confusion of the curves, several separate sheets could be used. It is to be noted that the ordinates give the distance of the center of gravity above the back of angle, or the distance (negative) below back of angle.

A convenient deflection diagram is given in Fig. 2. Any simply-supported steel beam, with either uniform or central load, when its depth and its extreme-fiber stress are known, can have its deflection determined from this diagram by a single multiplication. The values given on the diagram are for beams 1-in. deep and with extreme-fiber stress 1,000 lbs. per sq. in. To obtain the deflection of any given beam, the value read from the chart is to be *multiplied* by the fiber stress in terms of thousands of pounds and *divided* by the depth of the beam in inches.

Such a diagram as this might be constructed on the basis of load, but it is more simple when made on the basis of stress, and the deflection of a beam under full load is obtained, which ordinarily is the quantity desired.

These two diagrams were designed and drawn by Professor O. H. Basquin, Professor of Applied Mechanics, Northwestern University, Evanston, Ill.

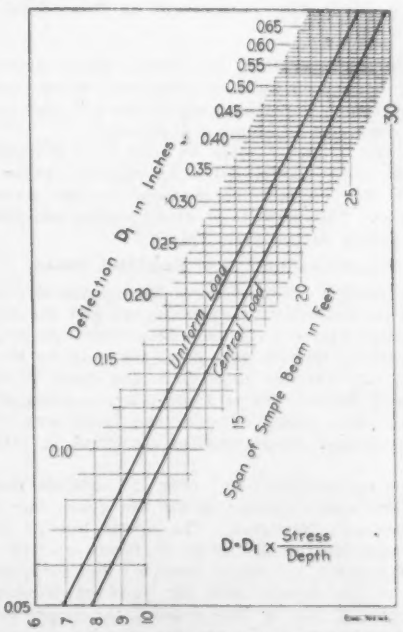


Fig. 2. Deflection Chart for Steel Beams.

The chart gives the deflection D_1 of a simple beam 1-in. high, having an extreme-fiber stress of 1,000 lbs. per sq. in.; E = 29,000,000.

The deflection of any other beam is:

$$\text{Deflection} = D_1 \times \frac{\text{Stress}}{\text{Depth}},$$

the depth being expressed in inches and the stress in 1,000-lb. units.

Profiles of Railway Lines From the Atlantic Coast to the Great Lakes.

(With two-page plate.)

Some years ago we published a set of profiles of transcontinental railways, extending from the Atlantic Coast and points on the Great Lakes to the Pacific Coast.* In this issue we present a number of profiles of railways extending from the Atlantic Coast to the Great Lakes and their outlet, the St. Lawrence. The small scale on which these profiles are drawn compels the omission of minor variations in grade, but the main characteristics of the lines are shown. Where rates of grades are marked on the profiles, the rates are the maximum in the location marked, and not the average for the entire rise; in many cases, of course, this maximum exists for only a short distance. Several groups of these profiles are of special interest in showing the comparative profiles of two or more lines between the same points.

In making such comparisons, however, it must be understood that the profiles do not afford a basis for criticism as to the relative excellence of the work done by the locating engineers, since different lines may pass through country of entirely different topographic characteristics. Even when located approximately in the same district, no direct criticism can be used on the profiles. One may be an old line built when low cost of construction was of much more importance than low-grade operating conditions, while another may have been built at later date, when traffic was of such importance as to warrant high construction cost to obtain low grades.

In the following notes we refer only to certain of the main characteristics, leaving the reader to study for himself the features of the several profiles. The railways of which profiles are given are shown on the map, Fig. 1.

Canadian and New England Lines.

In the first place, we have three pairs, of comparative profiles in eastern Canada and the New England States: (1) two lines from the coast to Quebec; (2) two lines from the coast to Montreal, and (3) two lines from the coast to the Hudson River; both of these last are parts also of through routes between the coast and the Great Lakes, whose profiles are given in other cuts.

The Intercolonial Ry. (Fig. 2) extends from Halifax approximately along the coast line to Quebec and Montreal. The newer line of the Transcontinental Ry. (Fig. 3) forms in part a cross-country or chord line to the coast-line loop of the Intercolonial Ry. between Moncton and Quebec, and by thus crossing the ranges and the high land of the interior it reaches much higher elevations than the older line. The Intercolonial Ry. practically touches sea level at different points, including Levis (opposite Quebec), and has maximum grades of 1.1 to 1.3 per cent. The Transcontinental Ry. keeps high above sea level, and its maximum grades are 1.1 per cent., with long grades of 0.4 per cent. against eastbound and 0.6 per cent. against westbound traffic. Near Quebec it maintains an elevation of approximately 150 ft. for crossing the St. Lawrence at the Quebec Bridge. The maximum elevation is 1,200 ft. A considerable part of the line is in wild and unsettled country, and water tanks or water stations are located at intervals of about 15 miles. It will be seen also that this line makes a saving of about 30 miles (or 4 per cent.) in distance, its length being 460 miles as compared with 490 miles between the same points on the other line. This new road is under construction, but not yet in operation. It was located by the engineers of the Canadian Transcontinental Railway Commission, and will form the eastern connection of the Grand Trunk Pacific Ry.

Fig. 4 shows the profile of the Grand Trunk Ry. line from Portland to Montreal, and Fig. 5 shows that of the approximately parallel route of the combined Boston & Maine and Central Vermont railways from Boston to Montreal. The former route (298 miles) has practically a continuous ascent from the coast to the summit elevation of 1,350 ft., and then a continuous descent to the St. Lawrence. The latter route (334 miles) has comparatively easy stretches at each end, while its middle or mountain section comprises two main summits, one a little over and the other a little under the 1,000-ft. elevation, or considerably below the summit elevation of the Grand Trunk line. As a matter of interest we give the following list of elevations on the line of the Central Vermont Ry.:

	Elevation above.	
	Lake Champlain, ft.	Sea level, ft.
White River Junction	267.4	361.4
Sharon	406.0	500.0
Randolph	597.5	691.5
Roxbury	915.0	1,009.0
Montpelier	428.2	522.2
Essex Junction	249.0	343.0
St. Albans	289.0	383.0
Swanton Junction	60.0	154.0
Stanbridge	56.0	150.0

Figs. 6 and 7 show the profiles of the Boston & Albany R. R. and the Fitchburg Division of the Boston & Maine R. R. (formerly the Fitchburg R. R.) between Boston and the Hudson River. The former crosses the river at Albany (201 miles) and there connects with the New York Central R. R.; the latter crosses the river at Mechanicville (190 miles) and extends thence to the West Shore R. R. at Rotterdam Junction. The profiles of these western connections are shown separately. Each of the two lines has two distinct summits, but while the former has its maximum elevation on the western ridge (1,453 ft.) the latter crosses this range at a low elevation by piercing it with the Hoosac tunnel. On the other hand, the Boston & Albany R. R. has a much lower elevation for its crossing of the eastern ridge.

New York and Chicago Lines.

Our illustrations show complete profiles of four routes between New York (including its New Jersey gateway) and Chicago, and in addition there are profiles of other lines forming parts of alternative through routes between these points. The four complete profiles (Figs. 8 to 11) are those of the New York Central Lines (L. S. & M. S. route), the Pennsylvania System (Fort Wayne route), the Baltimore & Ohio R. R. and the Erie R. R. There is also in Fig. 12 the profile of the alternative line of the Pennsylvania System from Pittsburg to Chicago by way of the Pittsburg, Chicago, Cincinnati & St. Louis Ry. instead of the Pittsburg, Fort Wayne & Chicago Ry. shown in Fig. 8. The respective distances by these several routes are as follows:

	Miles.
N. Y. Central Lines (L. S. & M. S. route)	980
N. Y. Central Lines (Mich. Cen. route)	975
Penn. System (Ft. Wayne route)	908
Penn. System (P., C., C. & St. L. route)	945
Balt. & Ohio (from Jersey City)	1,045
Erie	999

The profile of the New York Central route (Fig. 8) is in marked contrast to the other three, owing to its avoidance of high summits and long steep grades; this is due to its location along the Hudson River and the shore of Lake Erie. The profile of the Pennsylvania R. R. proper, between Jersey City and Pittsburgh (Fig. 9) shows something what may be done in improving original locations, the dotted line indicating the new low grade route for freight traffic. The profile of the Baltimore & Ohio R. R., like that of the Pennsylvania, shows a very high and steep peak (at the Alleghanies). The profile of the mountain or rough-country portion of the Erie R. R. is more broken than any of the others, and while it has no such high summits as the Pennsylvania and the B. & O., it shows the broken country which the line traverses.

New York and Buffalo Lines.

Profiles are given of five lines between New York (including its New Jersey gateway) and Buffalo. Two of these are included in the New York-Chicago profile of the New York Central

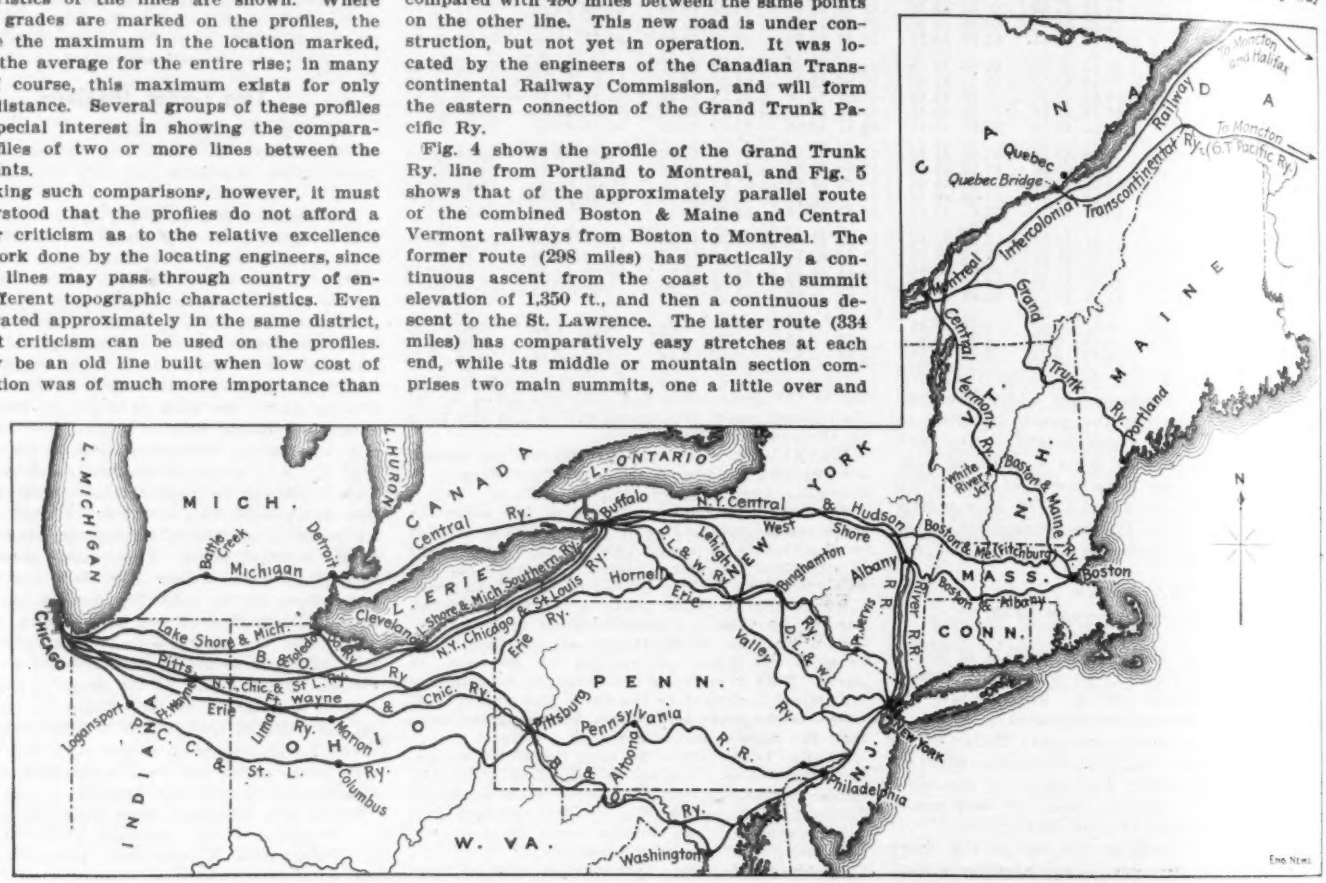


FIG. 1. MAP OF RAILWAY LINES WHOSE PROFILES ARE GIVEN ON FIGS. 3-8 OF THE ACCOMPANYING INSET SHEET.

*Engineering News, June 10, 1897.

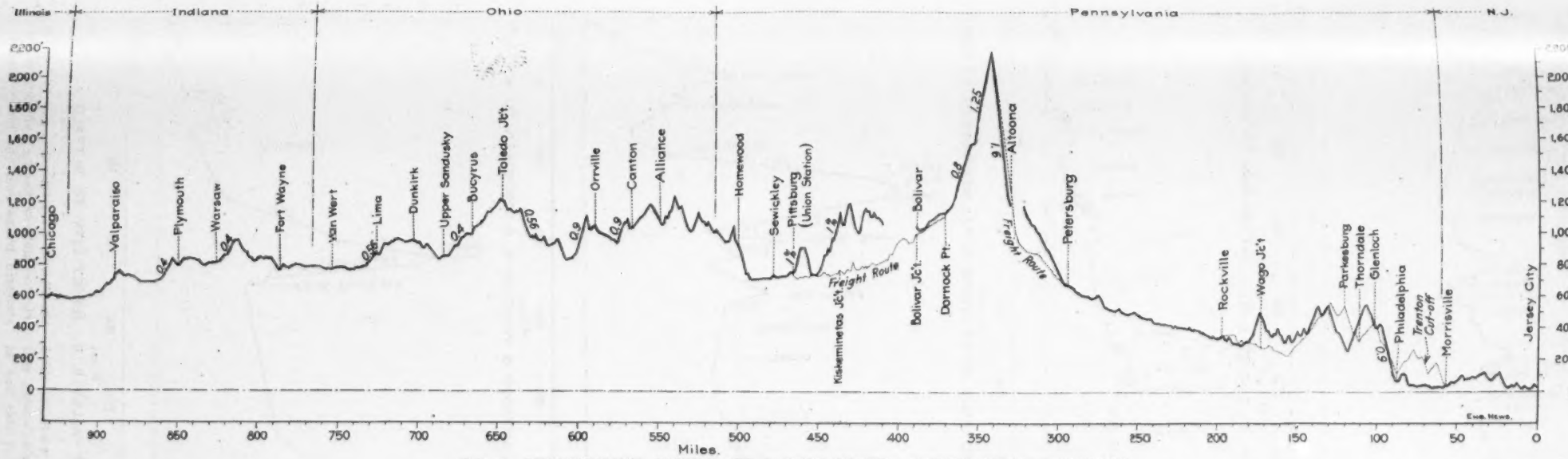


FIG. 9. PENNSYLVANIA SYSTEM (FT. WAYNE ROUTE); JERSEY CITY TO CHICAGO.

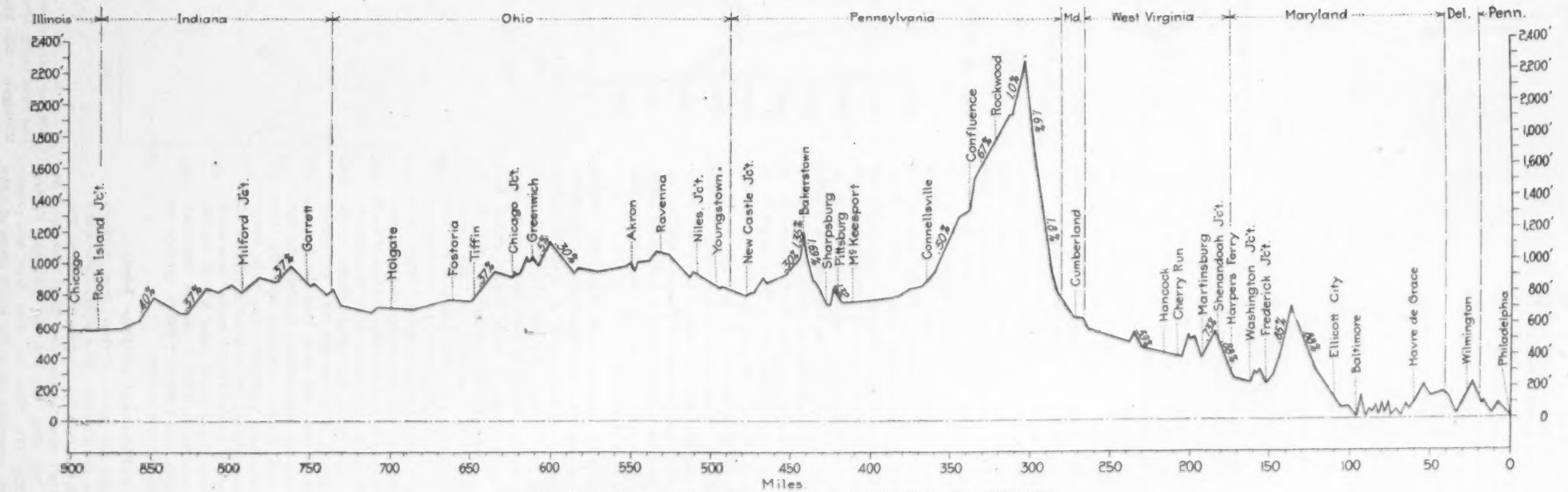


FIG. 10. BALTIMORE & OHIO R. R.; PHILADELPHIA TO CHICAGO.

R. R. (Fig. 8) and the Erie R. R. (Fig. 11). The three others are given separately in Figs. 13 to 15. The map, Fig. 1, shows the relations of the several routes to each other, and the distances by these five routes are as follows:

	Miles.
N. Y. C. & Hudson River Ry.	439
West Shore R. R. (N. Y. Central Lines	449
Erie	425
Del., Lack. & Western R. R.	411
Lehigh Valley R. R.	462

The two parallel profiles of the New York Central R. R. (Fig. 8) and the West Shore R. R. (Fig. 13) afford an interesting example of developments in railway affairs. The latter road was built during the '80's as a direct competitor of the old established New York Central, paralleling it as closely as possible, but with a line having less favorable operating conditions. In course of time (and no very long time) the new road was acquired by the older one, and was utilized to relieve the heavy traffic of its main line. The unfavorable operating conditions are now largely avoided, at least as far as through traffic is concerned, by combining the two lines. In comparing the two profiles, therefore, it must be remembered that for operating purposes these two roads are used partly in combination. That is to say, trains pass to and from the West Shore and New York Central lines at numerous places, as local and temporary conditions may demand. Such places are Schenectady, Rotterdam, Utica, DeWitt, Syracuse Junction, Lyons, Fairport, Churchville and Buffalo. For example, a heavy freight train pulling out of Buffalo over the West Shore R. R. proceeds eastward on this line until it reaches Syracuse; from Syracuse to Utica it passes over the main line of the New York Central R. R. and from Utica to Albany (or West Shore R. R. station at Ravena) it goes by either this main line or the West Shore R. R. as traffic conditions may dictate. In the same way, westbound trains are sometimes run over one division and sometimes the other, so that in actual operation the trains almost always follow a combined profile rather than either one of the two separate profiles of Figs. 8 and 13.

In striking contrast with these two profiles (Figs. 8 and 13) are those of the Delaware, Lackawanna & Western R. R. and the Lehigh Valley R. R. (Figs. 14 and 15), which attain much higher elevations and have much more accentuated profiles. Each profile shows four main summits; the profile of the D., L. & W. R. R., however, is the more irregular of the two. The profile of the Erie R. R. line to Buffalo (Fig. 11) represents a line of intermediate character. While it is more broken and has higher summits than either of the New York Central lines (Figs. 8 and 13), it is very much more favorable to traffic than either the Lehigh Valley or the Lackawanna (Figs. 14 and 15). An inspection of the map will show that the location represents an intermediate between the two river and plateau locations and the two cross-mountain locations. The total difference in elevation of terminal points on all the lines is about 600 ft., while the summit elevations range from about 800 ft. on the easier profiles to 1,750 ft. on the intermediate profile, and 1,800 to 2,000 ft. (nearly) on the two difficult profiles.

Buffalo and Chicago Lines.

Profiles are given of three lines between Buffalo and Chicago. That of the Lake Shore & Mich. Southern Ry. is included in Fig. 8. The others are those of the New York, Chicago & St. Louis Ry. (Fig. 16) and the Michigan Central Ry. (Fig. 11). The two first lines are closely parallel, especially along the south shore of Lake Erie, as may be seen by the map, while the third line runs north of the lake, through Canada, and Michigan. The sharp depression of this line at the Detroit river tunnel is met by the use of electric locomotives having sufficient power to haul standard trains over the heavy grades.

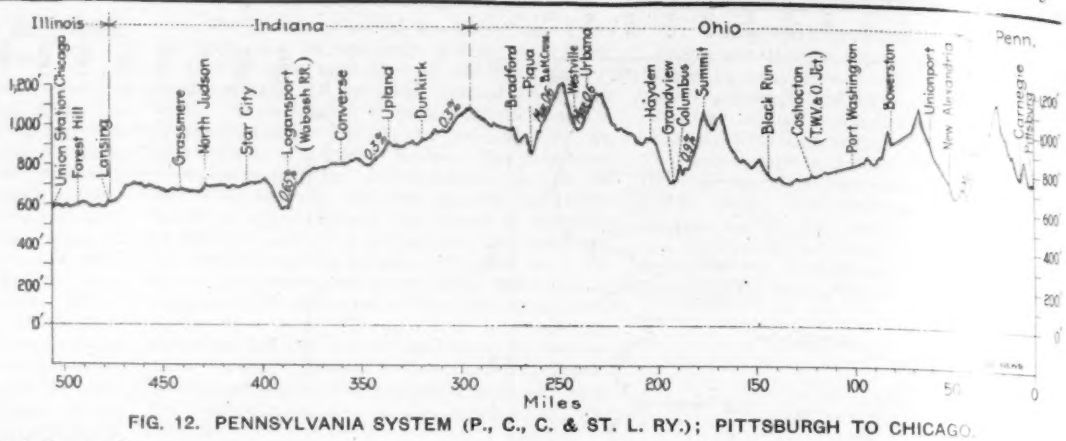


FIG. 12. PENNSYLVANIA SYSTEM (P., C., C. & ST. L. RY.); PITTSBURGH TO CHICAGO.

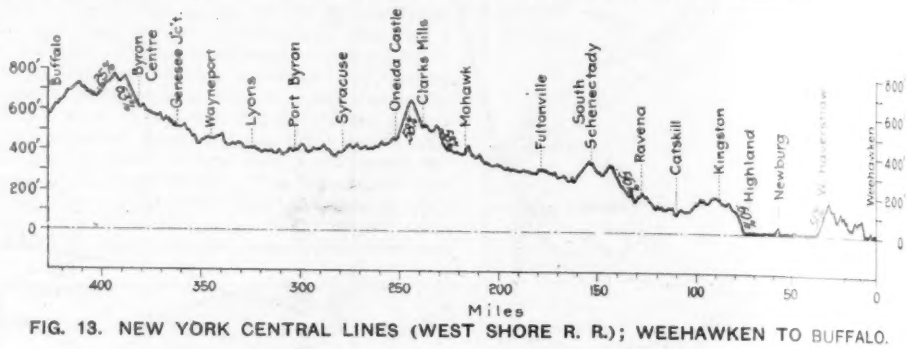


FIG. 13. NEW YORK CENTRAL LINES (WEST SHORE R. R.); WEEHAWKEN TO BUFFALO.

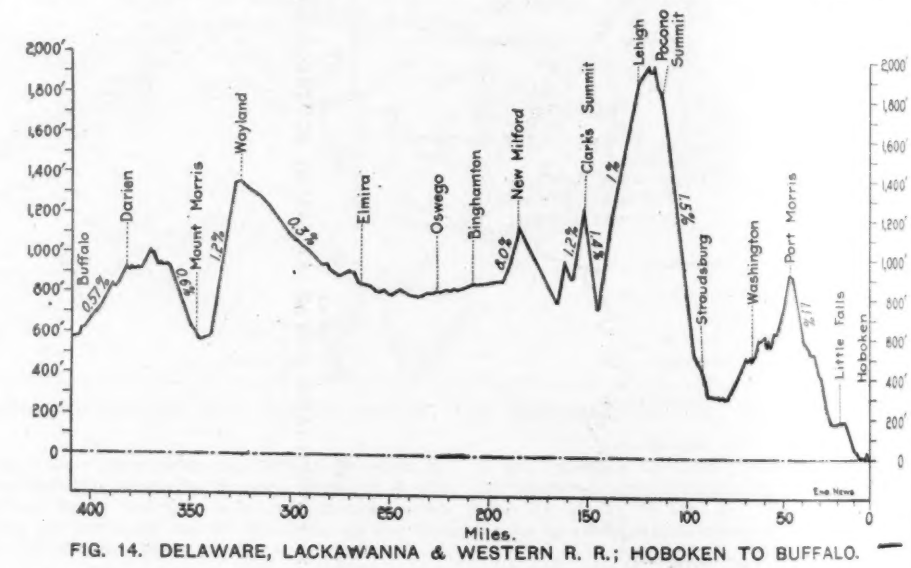


FIG. 14. DELAWARE, LACKAWANNA & WESTERN R. R.; HOBOKEN TO BUFFALO.

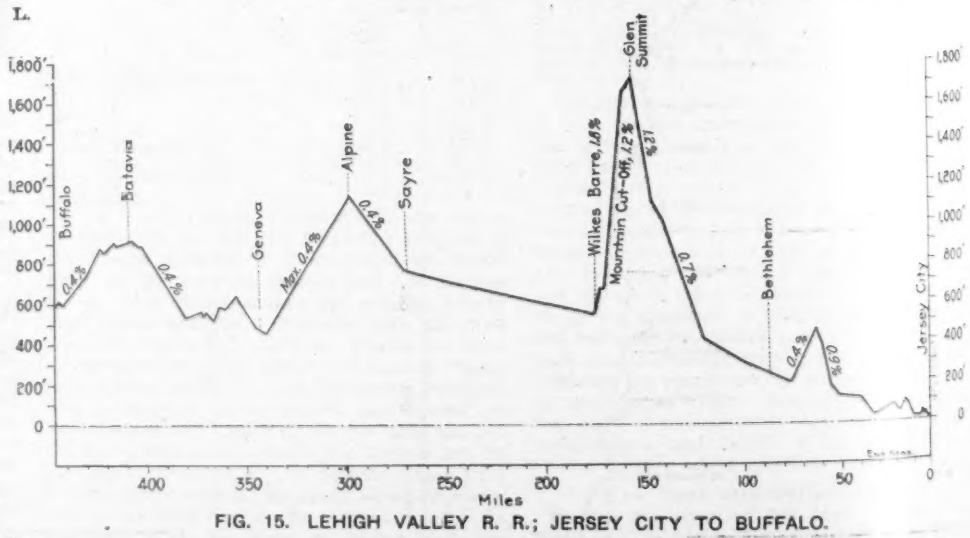


FIG. 15. LEHIGH VALLEY R. R.; JERSEY CITY TO BUFFALO.

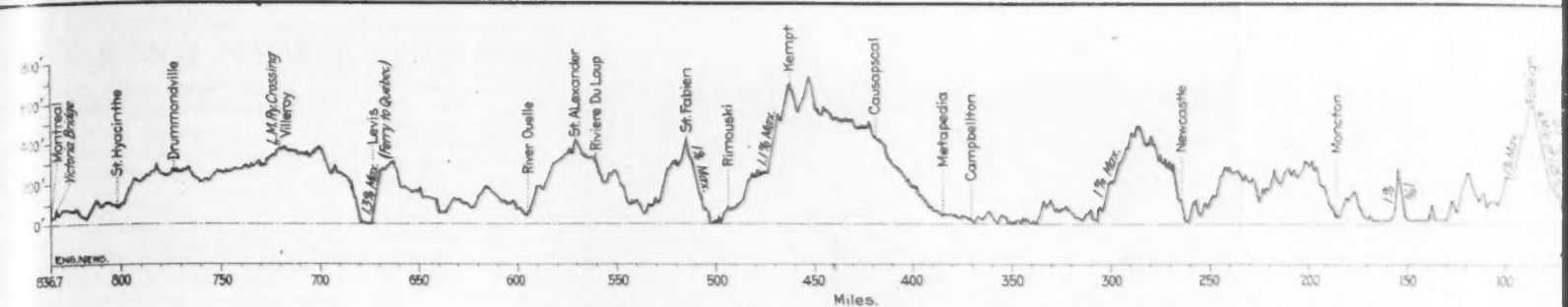


FIG. 2. INTERCOLONIAL RY.; HALIFAX TO QUEBEC AND MONTREAL.

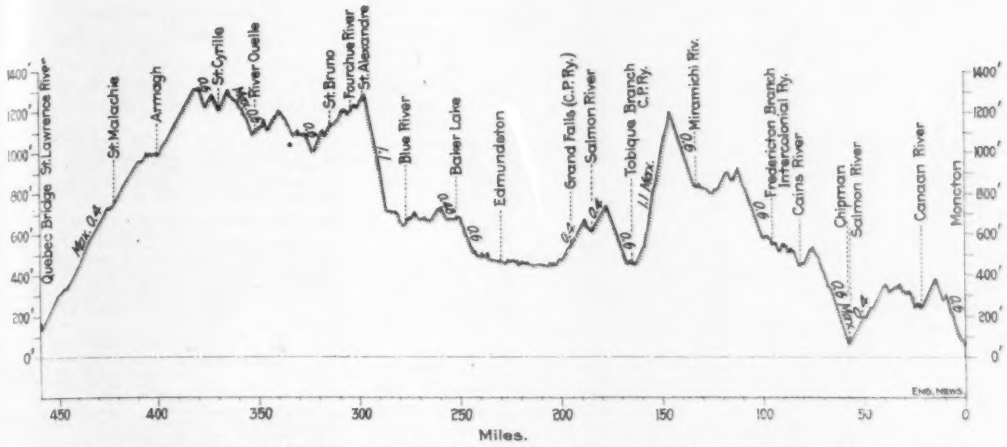


FIG. 3. TRANSCONTINENTAL RY. (GRAND TRUNK PACIFIC RY.); MONCTON TO QUEBEC.

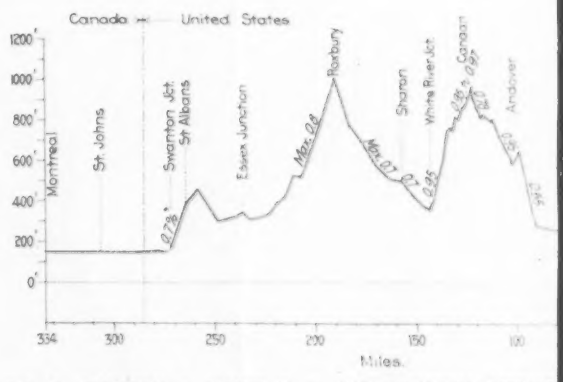


FIG. 5. BOSTON & MAINE R. R. AND CENTRAL VERMO MONTREAL.

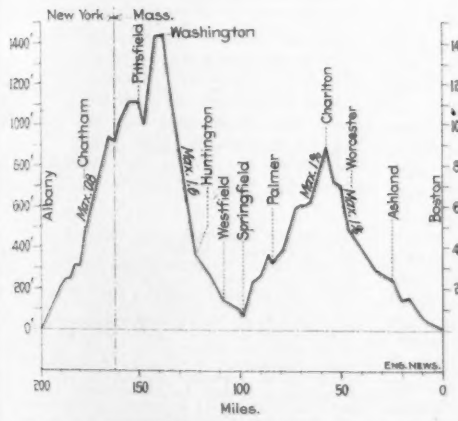


FIG. 6. BOSTON & ALBANY R. R.; BOSTON TO HUDSON RIVER.

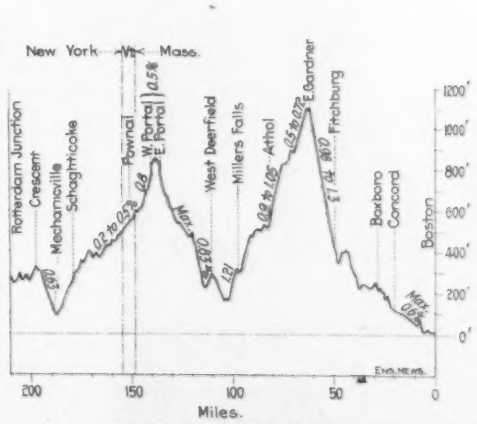


FIG. 7. BOSTON & MAINE R. R. (FITCHBURG DIVISION); BOSTON TO HUDSON RIVER.

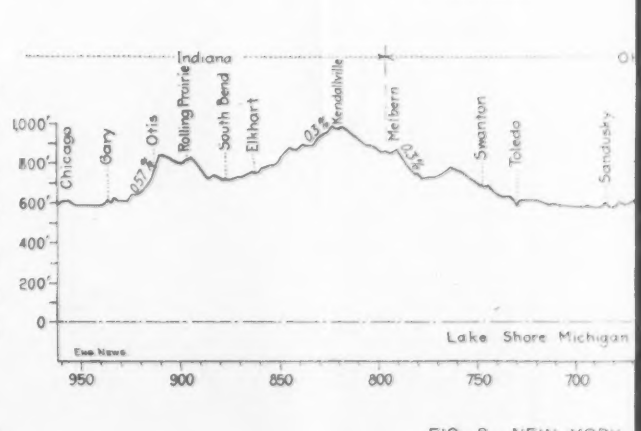


FIG. 8. NEW YORK

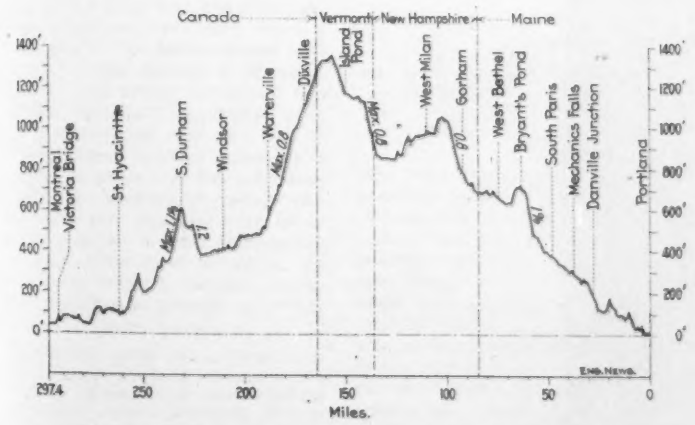


FIG. 4. GRAND TRUNK RY.; PORTLAND TO MONTREAL.

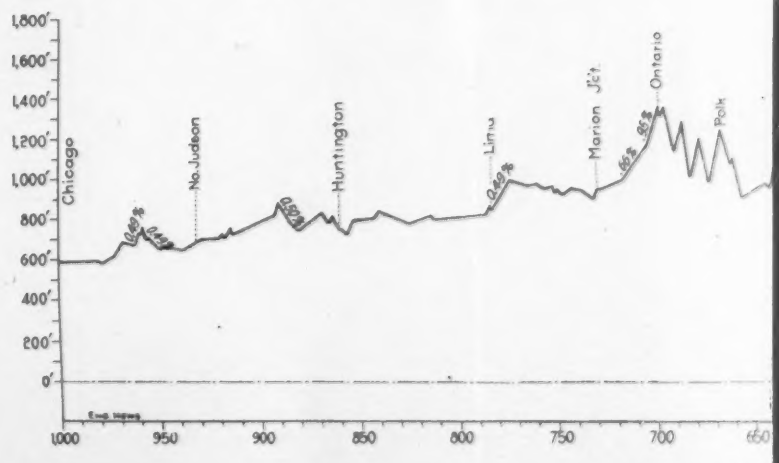


FIG.

PROFILES OF RAILWAY LINES FROM THE ATLANTIC COAST

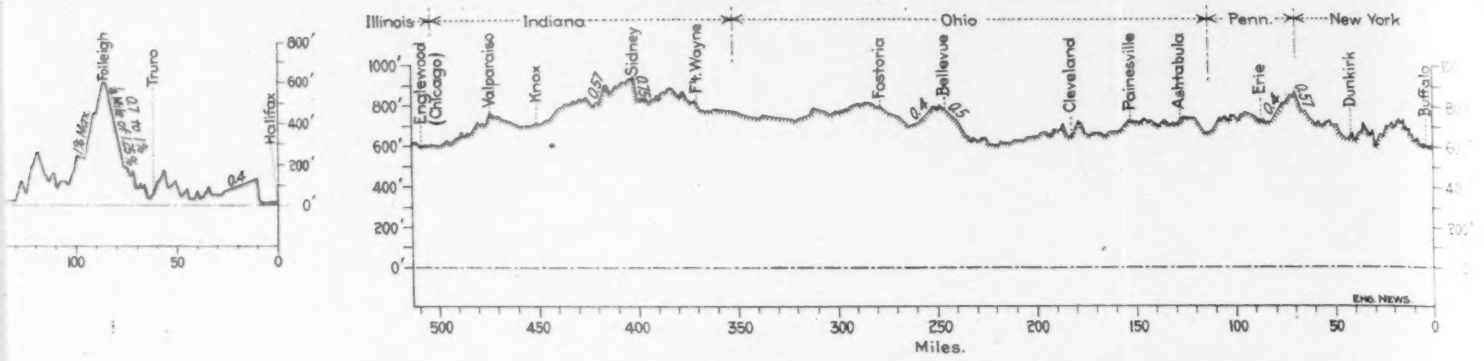
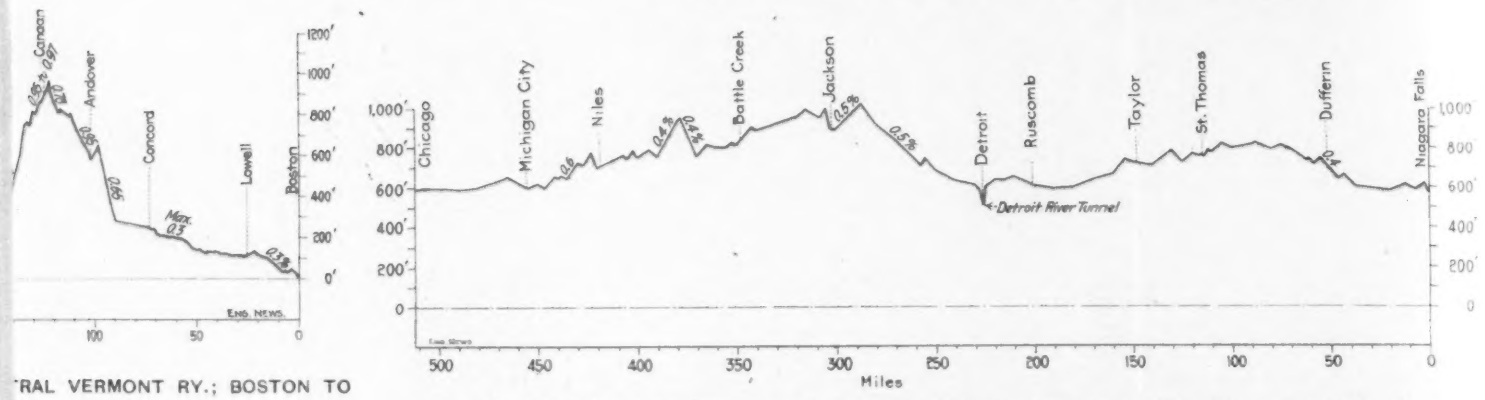
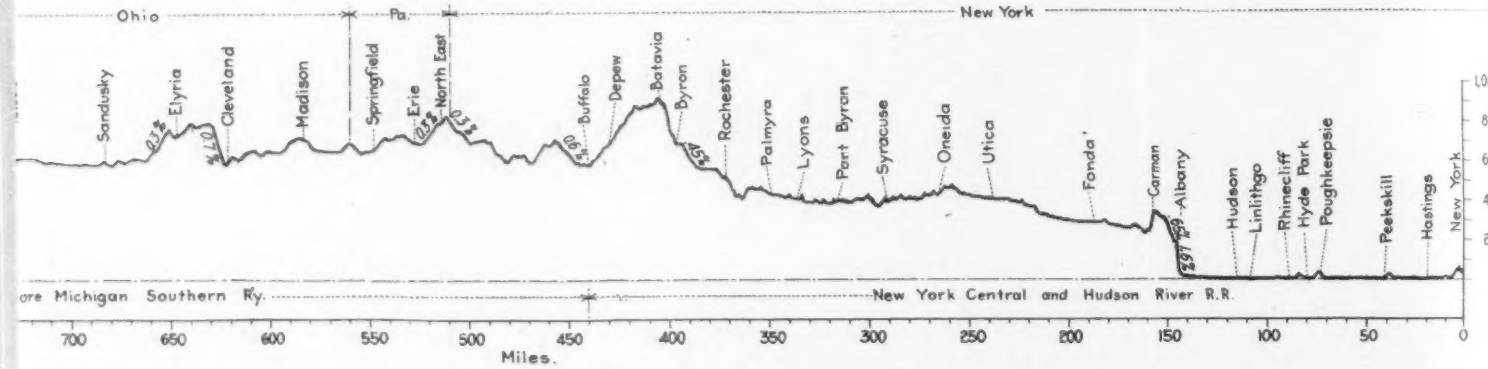


FIG. 16. NEW YORK, CHICAGO & ST. LOUIS R. R.; BUFFALO TO CHICAGO.



RAL VERMONT RY.; BOSTON TO

FIG. 17. MICHIGAN CENTRAL R. R. (NEW YORK CENTRAL LINES); NIAGARA FALLS TO CHICAGO.



EW YORK CENTRAL LINES (LAKE SHORE & MICHIGAN SOUTHERN ROUTE); NEW YORK TO CHICAGO.

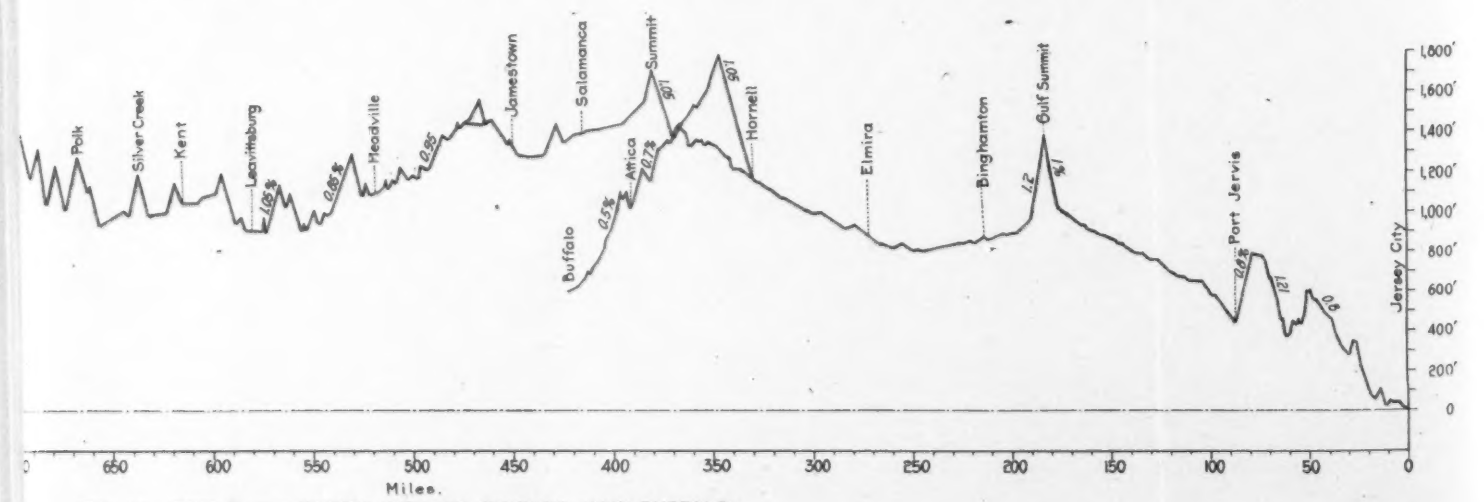


FIG. 11. ERIE R. R.; JERSEY CITY TO CHICAGO (AND BUFFALO).

OAST TO THE ST. LAWRENCE AND THE GREAT LAKES

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Dust Explosions in Coal Mines.

The recent terrible explosion in the Cross Mountain coal mine at Briceville, Tenn., is another fearful object lesson of the dangers of coal dust. The dust conditions in the mine are described as follows in a staff article in the Dec. 16 issue of the "Mining and Engineering World":

> The mine was known as a dry and extremely dusty mine. Not a drop of water is found in the mine workings or rooms driven off from the 27 cross entries. The entries are driven at 500-ft. intervals. The coal dust accumulated in the main and cross entries was so thick that one's feet stirred up a vast cloud when walking through it. The experienced miners recognized the grave danger and many of them quit work at this mine some months ago and sought employment elsewhere because the dust was allowed to accumulate; no attention was given to either wetting it down frequently or to cleaning it up for removal from the mine except in a few isolated and unimportant cases at infrequent intervals throughout the mine. These men knew the danger and expected an explosion at any time.

The fact that coal dust in a mine can cause a disastrous explosion has been well known to experienced mining engineers for more than a quarter of a century. The experimental and demonstration work by the Bureau of Mines in the past two years has surely impressed this fact on the mining fraternity generally. Not only has it been demonstrated that coal dust in a mine—or in any other confined space—is a source of danger, but a great deal has been done in the development of methods to reduce this danger, such as moistening the dust with water sprays or steam, sprinkling it with deliquescent salts, mixing it with stone dust to reduce the explosibility, and removal with vacuum sweepers. The latter method is favored by "Coal Age," which says in a recent issue:

> Experiments, especially with steam, have been quite successful in the face of active opposition by those who believed humidifying was injurious to men and weakening to roof. However, it is in the removal of the dust that radical changes are to be expected, and on this plan present thought is now centered.
>
> Perhaps no one is ready to affirm that a dust collector can be devised to remove all dust from coal mines. The crevices in the gob make such a result well-nigh impossible. Several machines, however, are now in use and have been successful in collecting large quantities of dust and thus providing safe zones.

At first, the chief difficulty with vacuum cleaners in mines was that the area to be cleaned had to present a smooth surface to the suction tubes. This would have made it necessary to dress the entry or roadway with concrete, which practice, aside from its cost, was impossible in most mines due to the movement of the strata and destructive effect of pressure.

One of the first practical cleaners to be used in mines was fitted with five suction tubes and in operation could clean 50 running yards of a large roadway in eight hours. Five men were required to operate the machine, and the cost was 12 cts. per running yard (English labor was used). The inital cost of such a dust collector was $720.

In those mines where this type of machine is used, after the dust has been removed from the surface, the gallery is painted with whitewash delivered by compressed air; the result is a clean entry and a well-lighted shaft bottom.

Recently, one improved collector has proved its ability to remove dust from uneven surfaces such as are presented in the average mine roadway. Air jets raise the dust from the roof and sides, and suction withdraws the dust-laden air. Either compressed air or electricity can be used as the source of energy.

Another Case of Dry Rot in a Slow-Burning Factory Building.

Notwithstanding the rapid growth in favor of reinforced concrete as a material for factory buildings, a great many factories of "slow-burning" construction with wooden columns and beams are still being erected. The use of wood in construction has in fact been rather stimulated during the past two or three years, by some reduction in market prices of lumber. Those who have to do with the actual work of construction, however, are aware that the quality of lumber obtainable today is not at all the equal of what was obtainable fifteen or twenty years ago. The engineer or the architect may write ever so strict a specification for the timber to be used in columns and beams, but he has to accept what can actually be obtained under the commercial conditions of the market.

We publish in this issue the result of experience in a Canadian cotton mill of slow-burning construction where serious deterioration from dry rot occurred within four years of the mill's completion. Investigation showed that the beams attacked by dry rot were in almost every case not long-leafed Georgia pine at all, as specified by the architect in the original construction, but Cuban or loblolly pine.

Such occurrences as this bring definitely home to the engineer that the long-predicted exhaustion of the timber supply is no longer in the future but in the present.

Timber is still obtainable in the market, but it is of a quality very different from that which was formerly available, and is too often lacking in reliability.

Mr. R. T. Crane on the Futility of Technical Schools.

For something over a dozen years Mr. R. T. Crane, of Chicago, has been throwing stones at the institutions of higher education in this country. Most of his missiles have been aimed at the colleges, but in a pamphlet recently issued he discharges a broadside against the technical schools.

Mr. Crane says that as this country "was immensely successful before technical schools were established," and as the boys who graduate from these schools have to have a large amount of practical training before they can render valuable service, therefore the education they obtain in the schools is worth little or nothing. In Mr. Crane's opinion, "the graduates of the technical schools are doing little or nothing to contribute to the real prosperity of the country," which is pretty rough on the engineering profession, since a large proportion of the engineers now in active life, in all branches of the profession, are technical school graduates.

It is a pity Mr. Crane is not a better informed and more careful critic, for many of the things he says have enough truth in them to be worth attention by engineers and engineering educators.

It is undoubtedly true that many youths take up the study of engineering with a most exaggerated idea of the prospects and profits that await them if they attain even a reasonable degree of proficiency in the profession. It is probably true that the average technical graduate is over-supplied with theory and none too certain how to apply theory to practice. It is probably true that a too large percentage of students in the engineering schools are spending their time to no good purpose and would be receiving a really better education and preparation for their life work under the discipline and hard work of a well-organized shop or office.

But it is one thing to criticise the technical schools and quite another to accept Mr. Crane's statement that all higher education is a humbug. The imbecility of his ideas—we are only attempting to match Mr. Crane's language with something equally strong—is illustrated when he lays down his own ideal scheme for the education of engineers. We quote as follows:

> The common sense way to make electrical engineers is as follows: Select, with the greatest care, boys about 16 or 17 years of age for machine shop apprentices. Watch over them carefully, in the first instance to see that they are what the employers are seeking as material for good machinists. If the foremen who keep close eye on the boys discover that some of them have unusual ability, let such be put in the line of direct training for electrical engineering. Such boys, after having two years of training in the machine shop (say one year at bench work and a year at tool work), shifting around considerably, would get the knowledge of that part of the work which is required to make of them good electrical engineers. Then let them spend six months in the testing department, six months drafting, a year in the erecting department and a year in the operating department.
>
> While working in this way they are surrounded constantly by an electrical atmosphere and will absorb, through observation and association, nine-tenths of all the knowledge they will need to have regarding electricity, and all this will have a splendid influence over them. The grandeur of the work is particularly inspiring, and the absorbing of all this information takes none of their time, as it is done unconsciously.
>
> During this period the boys could attend night school as much as is necessary and be furnished books on the science of different lines of electrical apparatus, books containing only such things as the best practical men know to be essential. If necessary, lectures could be given advantageously by the company's own engineers who know decidedly better what these boys require than any school teacher could possibly know.
>
> This would make five years in all, and then you would have a young man who, at 21 or 22 years of age, would be a fairly good electrical engineer. Such a man is likely to make his mark and certainly should be of considerable value to any one requiring his services. Besides this, he would have been earning his living all this time.

The best comment on Mr. Crane's proposed plan is, to say that it is, in substance, actually in operation. That is to say, machine shop apprentices by the hundreds have the opportunity to gain an education in exactly this way. If a boy has the necessary mental ability, the ambition and perseverance and the physical stamina to work days and study nights, he might go through such a course as Mr. Crane prescribes and at the end be a more valuable employee than the boy of equal ability and industry just graduated from an engineering school. But how few are the boys who are either able or willing to go through such a course?

And how deficient must be such a boy's grounding in the foundation principles of engineering compared with a boy who has worked hard four years on physics, chemistry, mechanics, hydraulics and their application to the solution of engineering problems?

Mr. Crane is simply densely ignorant of the breadth and range of technical information and ability which are demanded of the engineer today. He is densely ignorant of the fact that Germany is to-day far outstripping us in mechanical engineering and the manufacturing in-

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dustries dependent upon it, because German manufacturers, who are generally themselves educated in technical schools, are utilizing the theoretical studies and the ability of their engineering school graduates.

A Proposed Law to Prevent Collusion and Graft in the Letting of Public Contracts.

At a recent meeting of the American Society of Engineering Contractors a paper was read by Major C. E. Gillette, of Philadelphia, outlining proposed changes in existing legislation governing the letting of contracts for public work. This is a subject of perennial interest and importance to both engineers and contractors, and Major Gillette's suggestions are especially worthy of consideration, by reason of his experience in unearthing frauds in public contract work.

Space does not permit us to print Major Gillette's paper, in which he explained in detail the reasons which had caused the framing of the various restrictions which he proposed, nor the discussion which followed it. We print below, therefore, only the principles which he suggests should be embodied in every law covering the letting of public contracts:

(1) All expenditures of public money for supplies and construction work in amounts of $100 or more shall be by formal written contracts. Purchases of less than $100 may be by written proposal and written agreement duly filed.

(2) No bid shall be asked until an actual appropriation of funds has been made for the work or supplies, and before bids are asked for public contracts, official itemized estimates of the cost of the proposed work shall be made and permanently filed in the office of the public official who invites the bids.

(3) All public contracts involving an estimated cost of $5,000 or more shall be advertised in three local papers having the largest sworn circulation, and in at least one trade journal of suitable type, sufficiently far in advance of the opening of bids to give the most distant bidder in the State a reasonable opportunity to see the notice in time to submit a bid after due investigation.

Contracts for less than $5,000 shall be so advertised that every bidder residing in the municipality (or county) in which the supplies are to be delivered or work done shall have a reasonable chance to see the advertisement or receive the notice in time to submit a proper bid, and every official charged with the duty of purchasing supplies or making contracts must keep in his office lists of all dealers or bidders who request their names to be put upon such lists whenever such work and materials as they specify shall be desired by the official, and notice sent them in ample time to submit bids.

Purchases and contracts involving less than $100 may in emergencies be made by telephone, provided at least three bids be obtained, and the bids and prices be scheduled for public inspection, all the bids and the acceptances to be confirmed in writing.

In case of contracts for yearly supplies to be delivered as needed, purchases shall be by single items. The lowest bidder for each item shall be given the contract for that item, provided that if any bidder does not thereby secure items for which the estimate for the year in question or the actual use for the preceding year shall amount to at least $100, such items may be awarded to the bidder who bid the next lowest for each item.

(4) Specifications for public contracts shall in all cases comply with the following requirements:

(a) They shall be clear, definite and complete, expressed with words used in their dictionary meaning and showing exactly what is required in the literal use of the words, which literal meaning must be used in carrying out the contract. If in any case questions arise in the execution of the contract that cannot be clearly answered by the specifications, the matter shall be adjusted by arbitration in which the contractor shall select one arbiter, the official the second, and they two shall choose a third. Provided, the contractor or any citizen or corporation doing business in the State shall have the right to take the matter into the proper court.

The advertisement, instructions to bidders, specifications and contract form must together cover all necessary information to bidders. They must be concise. Unnecessary verbiage and repetitions must be omitted. Everything must be said once, clearly, and once only.

(b) They shall be itemized in full detail, the unit of every kind of material entering into the structure appearing in the schedule of prices bid.

(c) No responsibility for contingencies shall be specifically put upon the contractor.

(d) The specifications shall be so worded and all arrangements and management concerning the bidding shall be such that all bidders shall be bidding upon fair terms for exactly the same structure or the same result, and upon terms of exact equality as to advantages or disadvantages in so far as the official calling for bids can control or embody in the bid or award.

(e) The terms "discretion of the engineer," "judgment of the engineer" or their equivalents shall not appear in any specification or contract as calling for their exercise after the opening of bids, unless they be accompanied by full explanation in the specifications showing exactly how they will be exercised in the case of any of the various contingencies with reference to which they are used shall occur.

(f) No requirement shall appear in the specifications that have a tendency to discourage bidding unless such requirement is manifestly essential to the work or to the public interest.

(g) There shall be no requirement in the specifications or in the management of the bidding that shall require any citizen to disclose the fact that he contemplates bidding or is interested in a coming bidding.

(h) Specifications must be so arranged that in comparing bids only one thing is to be taken into consideration, the total cost of the work.

(i) The specifications and drawings must all be ready for distribution and freely distributed as soon as the advertisement appears. No charge in excess of actual cost shall be demanded for any specifications or drawings accompanying them. They must be sold or furnished free to any one who asks for them without requiring any information from the party asking for them, and they must be returnable at cost after the opening.

(j) No specification shall require the contractor to follow the specifications and at the same time be responsible for accomplishing certain results, or to guarantee the endurance of the work, or to be responsible for the repairs for any time after the completion of the work according to the specifications.

(k) Specifications or instructions to bidders must suggest that every bid should be enclosed in two envelopes, the inner sealed with wax and the outer not showing that a bid is enclosed.

(l) The official estimate shall be printed in the specifications with the information that no award shall be made for an amount greater than the total of the estimates and no supplemental contract increasing the work beyond that limit will be legal. Also that no bid will be accepted in which the price bid on any article is more than 10% greater than the estimate, and that if in the execution of the contract it be necessary to increase the amount of any item more than 10% beyond the estimate, the price of such increase shall be determined by arbitration subject to court action, as specified in Sub. Par. (a) above.

(5) Every citizen and every corporation doing business in the State shall have the full right to bid on any public contract and have the bid accepted if it is the lowest.

(6) Bids shall be opened in public. All bids received must be kept and opened. Bids with erasures or changes in figures that affect the cost of the work must be thrown out. The public shall have the right to inspect the bids at the opening.

(7) Whenever bids are advertised for, they must be opened at the time mentioned, and an award must be made to the lowest bidder. Otherwise, the lowest bidder shall have a legal claim for damages equal to the profits had the contract been executed.

(8) Any citizen of the State and any corporation doing business in the State shall have the right of injunction in the proper court to require compliance with this law, and such citizen or corporation shall have the further right to appear as a party in interest in any suit or adjudication between the contractor and the city official whenever the matter of public contract comes before the court.

(9) In the execution of all contracts, inspectors duly appointed according to law by the public official shall have full power to see that the specifications are literally carried out and the completion of the work or the delivery of the goods shall be followed by the proper certificate of the inspector that the work and materials have been in accordance with the specifications. This shall relieve the contractor of all further responsibility.

We believe that in general the principles suggested by Major Gillette will meet with the approval of engineers. Perhaps there will be most dissent from Clause 7, making compulsory the award to the lowest bidder. We believe the large majority of engineers are of the opinion that such a restriction is one of the main reasons why public work is often more expensive and less satisfactory than work carried on by a private concern.

It is the general experience of engineers that no specification and no amount of supervision can get first-class work from a fourth-class contractor. Admittedly, the character of the work to be done makes a vast difference. Where it is a simple matter of excavation, of course, about the worst that can happen from letting the work to an incompetent contractor is that he will fail and involve the work in litigation and consequent delay, which may be very costly. If the work, however, is of a complicated character, such as the erection of a building or a bridge, the production of a machine or even the putting down of a hazardous foundation, it is impossible to secure good work from an incompetent contractor, and laws compelling the award to the lowest bidder have for this reason often proved injurious to the public welfare.

We must express our disagreement, also, with Major Gillette in his insistence that the engineer should have no discretion whatever with regard to the carrying out of the contract. There are few classes of work where one can find an engineer with sufficient knowledge and ability to fulfil the counsel of perfection as respects the drafting of specifications which Major Gillette thinks should be required by law.

Further than this, we do not believe that a law embodying the principles suggested above, nor any law that could be drafted, could avail to prevent fraud and loss to the public if the engineer in charge is incompetent or dishonest.

Nevertheless, most of the things which Major Gillette suggests might well be embodied in law. While it is true that no law can make men honest who would wilfully be otherwise, it can establish a standard of practice which is a useful guide to those who wish to follow a correct course.

It is undoubtedly true that laws governing the letting of public works throughout the United States are full of all manner of absurd and unjust requirements, injurious both to honest contractors and to the public.

Major Gillette's suggestions are in any event a useful guide to engineers in drafting specifications and contracts and are well worth putting on record for that reason alone.

Engineers as Members of Public Service Commissions.

We noted recently the action taken by the Brooklyn Engineers' Club, urging the appointment by Governor Dix, of an engineer on the Public Service Commission of New York City, to fill a vacancy which will occur on February 1, when Commissioner McCarroll's term of office ends. Another organization, the Technical League, of New York City, has since added its voice to the resolution of the Brooklyn Engineers.

The "Evening Post" of New York City interviewed some of the members of the New York Public Service Commission regarding this recommendation of the Brooklyn Engineers' Club, and in its issue of December 14, quotes two of the members of the Commission as follows:

"What the city wants on this board is men of common sense," said Commissioner Cram. "It needs men who have a broad outlook on things, not men whose vision has been warped and narrowed by constant attention to detail. It wants men who comprehend business from the bottom up and from the top down; men who understand the relations of the great corporations to the public, and who can bring the two into accord. They must appreciate the problems of these corporations, and know how to deal with them—know where regulation ends and where destruction begins.

"For such positions engineers are not fitted. Their training in detail is liable to narrow rather

than to broaden them. As a matter of fact, where the training is obtained is of little moment; what counts is a broad outlook and understanding and common sense.

Commissioner Eustis agreed with him. "No, we don't want an engineer on the Board," said he. "We have a consulting engineer already, and why should we have another on the Board? It would only lead to friction. I think that no matter how good a man you appointed, an engineer would be an objection."

With most of what Commissioner Cram says above, there can be no disagreement. A man should not be appointed on such a body as a Public Service Commission because he is an engineer, or because he is a lawyer, or because he is a doctor, or for any other reason except that because he has the ability to fill the position and perform the duties in a satisfactory manner. Most emphatically does such work as that on the Public Service Commission demand men with a broad outlook, as Commissioner Cram says. And it is eminently true that the average man in any occupation, or even the exceptional man, be he engineer, doctor, lawyer, clergyman, grocer, farmer or banker, devotes necessarily so much of his time to detail work that he lacks that broad outlook which is admittedly an essential feature to a man's highest usefulness. It may freely be admitted therefore, that engineers competent to fill a position like that on the Public Service Commission, are rare, just as bankers, or lawyers, or farmers, who are competent for such a position, are rare.

It may be admitted also that an engineer to be competent for such a position, must be one who has had experience in dealing with large problems, where he has gained the necessary breadth of view. That such men are to be found in the engineering profession, whose knowledge of detail has not prevented them from gaining a broad outlook, we fully believe. While it is admittedly true that close attention to detail, which prevents a man from studying and dealing with large problems, does have a narrowing effect, it is also true that knowledge of detail and ability to judge concerning it is a very necessary part of the equipment of the man who has important decisions to make.

There are many questions which come before such bodies as a Public Service Commission where the decision may turn on a matter of small detail in construction, operation, or maintenance. Of course the Commission may properly ask advice of its engineers on such matters of detail, but it would be of great advantage if they could judge for themselves of the breadth and accuracy of their engineer's report.

The questions raised by the Brooklyn Engineers' Club recommendation, however, and by Commissioner Cram's comment upon it, are much broader than the mere question of appointment to the vacancy on the Public Service Commission. Is the public not losing greatly through its failure to be guided by the opinions of able engineers on the larger economic problems which the country has to meet. A very large part of the public questions of the day are really questions of engineering. Without the technical knowledge of the engineer, there is risk all the time of unwise decisions. Public funds are being expended in directions where a profitable return cannot be expected, because public officials lack knowledge which engineers possess. In other directions enterprises are lying dormant and neglected, which, if properly prosecuted would result in great public benefit. As has often been set forth in these columns—the public greatly needs the advice of the best experts in a thousand different fields of industry, and it can well afford to pay almost any price for such expert advice.

We do not have to argue merely on the ground of what the engineer might do if he had the opportunity. Engineers have served with distinction on many public bodies, dealing with the largest questions, and have contributed toward success, advice and opinions that others could not have given. The country to-day owes an enormous debt to the engineering profession for work that has been done during the past three-quarters of the century in the development and up-building of industry, commerce, and municipal life. Our best managed railway and industrial corporations give the engineer a large place, not only in the technical work of his profession, but in administrative positions.

No one will claim that an engineer, merely because he is an engineer, is fitted necessarily to occupy executive or judicial positions. That would be absurd; but it is equally absurd and contrary to all experience to declare that an engineer is unfitted for such responsibilities by reason of his professional ability and experience.

LETTERS TO THE EDITOR.

The Quebec Bridge Letting; a Defence of Contractors' Guarantees.

Sir: In your issue of November 16, 1911, Mr. Gustav Lindenthal regrets the parsimony of engineering fees at the first Quebec letting and also criticizes the method of conducting the second letting. He believes that had Mr. Cooper received a larger fee he could have checked the contractor's design and thus have avoided the first failure.

A letting conducted as was the second, on the engineers' detailed plan, however lavish the fee, has no satisfactory provision for such checking unless it can be placed on the contractor. The contractor's engineers, being ordinarily more expert specialists than the consulting engineer, would provide a more satisfactory check even than an independent engineer. But the only way the contractor can be compelled to check is by requiring him to guarantee the structure as to design as well as workmanship and materials. Mr. Lindenthal is therefore inconsistent when he bemoans the lack of engineering fees at the first letting which resulted in collapse by failure to check the contractor's plans, and at the same time criticizes the increased cost that resulted from a guarantee by the contractor on the engineer's plans at the second letting.

Mr. Lindenthal says:

> The old bridge fell down; it was the fault of the engineers. Engineers are irresponsible; they have no wealth. They cannot respond in damages, but the contractor can, so if he is anxious enough for the contract and the profit from it, put the whole thing on him. What a conception of professional duty, honor and dignity for engineers!
>
> It is quite true that the contractor has and should have the sole resposibility for the erection of the structure, as the erection, once its method is decided upon and approved by the engineer, depends largely on the management and organization of his own forces and appliances. But this responsibility is sharply distinguished from that for the design and for the strength and safety of the bridge and for its erectability. This should be wholly the responsibility of the engineer. * * * *
>
> Engineers who draft such specifications or countenance them, make the engineering profession ridiculous, and lay it open to the reproach, not infrequently heard in the press and from public men, that they lack in executive and administrative ability.

The Canadian Government was endeavoring to erect a bridge, which was not primarily an effort to elevate the honor and dignity of engineers. The latter is incidental to the former. When the old bridge collapsed much honor and dignity of engineers went with it, but that did not materially help the Canadian Government. That a lesson was drawn from that failure is shown by the fact that at the second letting the contractor was made responsible and no further chances were taken on the honor and dignity of engineers.

If engineers cannot guarantee their work with something more material than honor and dignity, they should place the responsibility on the contractor, who need not bid if he does not wish to assume the burden. Why should the innocent purchaser, whom both engineer and contractor are endeavoring to serve, be compelled to pocket a loss for which only the latter are at fault? The contractor, who can be held legally responsible, is anxious to shift it to the engineer who cannot be held but who is willing to trust to "professional duty, honor and dignity." That engineer is lacking in administrative ability who *neglects* such safeguards in his specifications.

The responsibility for design and erection can *not* be sharply distinguished, and nothing is much more difficult than to determine whether faulty workmanship or faulty design is responsible for a collapsed structure. Therefore, combine the two, lessening the danger of defective work due to lax inspection, and allowing the contractor to share in some slight degree of honor and dignity, bearing in mind that the purchaser's interests should be held paramount to all others.

Mr. Lindenthal may have written an excellent article, but it can hardly be given full credit for sincerity throughout because of his biased position. Under such conditions it would seem wiser to refrain from criticism, your editorial to the contrary notwithstanding. Very truly yours,

Daniel B. Luten.

Indianapolis, Dec. 14, 1911.

On the Need of Biographies of Engineers.

Sir: The editorial in your issue of Nov. 23, under the title of "The Need of Engineering Reference Libraries," suggests an idea in regard to biographies of engineers, of which the writer has found a surprising scarcity.

It seems that most biographies are written by men of literary tendencies, who prefer to record the lives of those with whom they are familiar, or with whom they have been more or less closely associated. The result is that the majority of the biographical works treat of literary or scientific men, leaving the memory of the engineer, who has spent the best years of his life in building up the country and raising the standard of his profession, to the brief obituary notices of the current periodicals, or to the condensed memoirs or resolutions of respect of some organization of which he was a member.

There can be no question of the benefit to be derived, by young engineers especially, from the study of the lives of the leading men of their profession; and by the cultivation of those characteristics which have enabled men to rise to the top of their profession. It is also evident that the most valuable biography can be produced by an associate who is familiar with the life and work of his subject from both a personal and professional standpoint.

There are doubtless many engineers who would be glad to record the lives of their friends and associates; and it seems that an opportunity is here presented for the national engineering societies to do a great work for the profession. It is due the members of these organizations to have their activities and accomplishments recorded. If a committee were appointed to arrange for the preparation of biographies of the deceased members, substantially all the leading engineers of the country would be included, and the profession generally would be greatly benefited.

T. M. Pittman, Jr.

Fulton, Ky., Dec. 4, 1911.

Structural Steel Stack at Garfield, Utah, Blown Down.

Sir: I note with interest a description of a structural and corrugated steel stack published in the News of Dec. 7, 1911, p. 683. It may interest your readers to know that this stack was blown down in a high wind on Nov. 10, 1911, having been in service just about a year.

The disaster is attributed primarily to the failure of the guy cables on one corner. The guys were ¾-in. galvanized steel strand instead of ⅝-in. as shown in the article, and were secured at the ends by passing the end about a thimble, doubling back and fastening the loose end to the standing part by means of ordinary cable clamps of a U-bolt pattern. The high wind stressed the cables to such a point that these loose ends pulled through the clamps at the lower or ground connection.

I might add that there were but three sets of cables in service, the second set from the bottom having never been erected.

This stack will be replaced at once with one of similar design, but with heavier corner angles and having a more thorough system of guys.

Yours very truly, C. W. Wilson,
Chief Engineer, Garfield Smelting Co.

Garfield, Utah, Dec. 12, 1911.

Why Reinforced-Concrete Buildings Fail.

Sir: In your issue of October 26, 1911, p. 498, the writer notes an article on, "Why Reinforced Concrete Buildings Fail," by Mr. Ernest McCullough, which deserves some comment from the standpoint of the successful concrete constructor.

In the majority of buildings where failures have occurred there has generally been used sufficient material, both of steel and concrete, to make a good job if it had been intelligently placed, and on the basis of this observation the writer is inclined to conclude that the majority

of failures are due to the ignorance of proper methods of design by those calling themselves engineers.

The failure of the Quebec Bridge was, as the writer looks at it, not brought about because the material used was insufficient to make a job that would stand up, but because it was improperly distributed; first, through the instrumentality of a faulty specification, and second by an improper make-up of the compression members in which the experiment was tried of placing nearly all of the metal in the webs and almost none at all in the flanges. The Commission to whom was entrusted the preparation of the plans for the proposed new bridge followed this latter faulty method of distribution of metal to a considerable extent, and, as the writer views it, failed to get much better results with expensive nickel steel than should have been obtained with a more rational make-up of section with the same grade of metal as used in the Forth Bridge. By this statement the writer does not wish to be misunderstood as advocating the expensive round column, but to advocate in the make-up in a box section the same proportion of flange and web as that which we adopt in the ordinary rolled channel and concerning which we have adequate test data.

Mr. McCullough refers to the tendency of the young engineer to go into extreme refinement in computation, yet in referring to the Quebec Bridge, he appears to attribute failure and complete collapse to an error of 15% in the computation of the dead weight! When we are supposed to have a 100% margin there must be some error radically greater than a 15% error in weight to produce such results, particularly when the collapse occurred before this dead weight was in place. This error, as the writer looks at it, is the failure to consider the suitable make-up of the section substantially as outlined and this same radical error occurs in the design of reinforced concrete again in the make-up of reinforced-concrete sections, though fortunately without such disastrous results in the majority of cases.

The same criticism regarding columns or rather the make-up of columns, applies to the concrete structure. The hooped column without vertical steel has been advocated by some from commercial motives based on the patent situation, whereas the vertically reinforced and hooped column is the only truly safe and conservative one for the engineer to use who expects to deal broadly with the rank and file engaged in the construction business. The absurdity of placing confidence in a large amount of vertical steel reinforcement is well illustrated by the total collapse of the Hencke Building in Cleveland, in which a little old hay wire was used as ties at more or less distant intervals in the length of the column.

As regards the question of working stresses, these as the writer views it are conservative or lacking in conservatism dependent entirely on the strength which may be developed under test with the design adopted. Four hundred pounds per square inch on the core of an old style Hennebique column is the limit which the writer would care to adopt in his practice, while with the properly hooped and vertically reinforced column, he would consider a developed pressure of over 3,000 lbs. per sq. inch, even more conservative than the former.

The recent failure of the Canadian Fairbanks Building in Winnipeg was the failure of a design which would probably nearly or quite meet the requirements recommended by the Joint Committee on Concrete and Reinforced Concrete, and the encouragement of this Committee of the less safe classes of construction or types of construction, regardless of the particular system or type of bar used, is well illustrated by this example. On the other hand, this building would probably not have collapsed had the practice of using warm water in mixing concrete at this season of the year been followed. Samples of the concrete taken from this building by the writer's Winnipeg representative, and kept in the office six days at a temperature of 65° to 70° F., hardened up nicely and proved to be a fair, ordinary concrete, yet the quality of the cement which may or may not have met the refinements of chemical composition considered best by some, was blamed for this accident.

The standard specification used by the writer for mixing concrete is as follows: "Whenever the temperature drops below 45° F., and before it reaches the freezing point, the water used in the mix shall be heated to 110° F."

The best Portland cement is readily chilled and becomes dormant at temperatures materially above the freezing point and the workmen, considering that no harm is done providing the concrete does not freeze, are prone to regard two weeks' time in the chilly fall weather as the equivalent of two weeks' time in the warm, dry summer weather, with disastrous results. The simple precaution of waking up the cement by the use of warm water in the mix, causes it to deport itself more nearly as it does in the summer season.

A fair illustration of this characteristic of cement was called to the writer's attention on the Bostwick-Braun Building, in Toledo, O. In this building, approximately 200 ft. square, when the third floor had been cast, and the concrete had remained on the forms two weeks without hardening appreciably, the writer received a telegram from the contractors stating that the cement used in the third floor was worthless and requesting him to visit the building at once. Having imperative engagements the writer was unable to visit the work under two days. These two days were warm and sunny and the cement showed marked signs of activity during this time and when he arrived at the building the scare had nearly blown over. There were only a few places on the floor where one could run a pencil into the concrete 5 or 6 ins., while the greater portion of the area had stiffened up about as much as concrete ordinarily hardens in the summer in 6 or 8 hours. The superintendent of the building, one of the brightest men the writer has had the pleasure of knowing, explained that his idea was that it was unnecessary to commence heating the water until the temperature was below freezing point and on thoroughly explaining the matter to him he took the necessary precautions in the stories above and with the same cement removed the centers every 10 or 12 days, although the temperature was somewhat lower than when the third floor was cast.

A piece of work was built in Southern Kansas, a two-way beam system, with panels 24 by 20 ft.; when the forms had been in place a month they were removed, and immediately thereafter a wire was sent the writer that one of these beams had deflected ¾ in. and requesting him to come at once. He merely wired back, "Prop it up and put in salamanders. Will pay you a visit in a month." At the end of a month at the proper temperature, the concrete was in excellent shape. A little plaster straightened out the beam line and it would be impossible to detect the displacement without an instrument, while the strength was not impaired. With ordinary simple beam reinforcement instead of continuous reinforcement, this work would have collasped and probably somebody would have been hurt. This is a fair illustration of the necessity of tieing concrete together by ample lap of the reinforcement.

In the discussion of designs, this distinction should be clearly born in mind: the engineer who designs for a given contractor who controls operations throughout can put out a type of design which would inevitably cause trouble if entrusted to the rank and file of those engaged in the building business. The engineer on the other hand who is engaged broadly in the commercial field of reinforced concrete in selling a distinctive type of design and reinforcing to all who desire to do business with him, is up against an entirely different proposition. His designs should be characterized by that degree of ultra conservatism which would preclude a sudden collapse or failure notwithstanding the negligence or shortcomings of the workmen and notwithstanding the question as to whether they knock the forms before concrete is more than half hardened and cured. In other words, his position should be to place upon the market something which is as nearly as possible absolutely *foolproof*. A clean record of no failures and no serious accidents can be maintained by an engineer in this field only through the exercise of this degree of ultraconservatism in his designs.

An engineer, if he possesses the characteristics of a true man, feels a keen sense of responsibility for the safety of the workmen putting up construction which he designs, and conscientiously tries in every way to render the incumbent risk in erection work the smallest possible. In erecting steel work under the writer's design a number of poor fellows have lost their lives, and in no instance could the writer see wherein he could in any wise have made provision against such accidents. With reinforced-concrete work on the contrary, it is possible with economical designs to throw certain safeguards against nearly all manner of carelessness and even negligence on the part of workmen and for this reason the writer is strongly disposed to adopt concrete construction in preference to steel in all cases where it is commercially adaptable to the work in hand.

We will now discuss pointedly what the engineer can do to render erection work safe in the line of concrete construction. Bearing in mind the fact that concrete, when first mixed, presents the characteristic only of mud and passes gradually by the chemical process of hardening through all stages from mud to a hard, rigid material, it is evident that unless the material in its earlier stages be properly supported it will not hold its form if these supports are removed before it is sufficiently cured. It is evident also that no design of reinforcement in concrete construction will permit the successful use of falsework unable to support the weight of the concrete.

What the engineer may do, however, by a rational design of reinforcement in the form of a net work in two or more directions and of ample length of rods, is to minimize the danger from a collapse of falsework improperly constructed, and in fact almost preclude the possibility of serious accidents from such causes.

The average carpenter foreman may overlook the necessary stays which give rigidity to the verticals in centering, and this oversight may cause a collapse. This has occurred in a number of pieces of work with which the writer was associated. In these various cases, however, the reinforcement in multiple directions continuous over two more panels, presented such a network that when the falsework collapsed, the soft mud merely fell to the next floor and even concrete cars fully loaded were held suspended by the network of reinforcement which merely sagged down slowly under the weight without suddenly dropping and without injury either to the men or the cars supported by it. This safeguard is entirely lacking in one-way reinforcement of the simple beam order with little or insignificant lap over the supports.

This safeguard of the lives of the men putting up concrete work is not limited merely as an insurance against loss of life through defective carpenter work, but it also safeguards against the loss of life through the more common error of judgment in premature removal of the forms in damp, chilly weather, when the concrete hardens or cures with extreme slowness.

A type of construction in which one-way reinforcement is used on the simple beam order will, when the forms are prematurely removed, collapse suddenly, and without warning, as was the case at Long Beach, in a recent accident in Winnipeg, and many others too numerous to mention.

On the other hand, where the natural or distinctive types of reinforced-concrete construction have been adopted by the engineer and the workmen have prematurely removed the forms before the concrete is sufficiently hard and rigid to maintain the form which it was designed to retain, there results a slow gradual sag, giving ample evidence of the gradual distortion of the concrete under compression. With these types a sudden collapse or failure by shear is impossible, due to the continuity of the reinforcement running in multiple directions, making it impossible for it to sag in a cylindrical curve but forcing it, on the other hand, to deflect with a curvature in two directions. The writer can cite numerous cases where in construction of this character deflection has taken place after premature removal of the forms and sometimes where this deflection has been so excessive that the concrete had ultimately to be removed and yet nothing more serious happened than the loss of a small amount of material.

Nearly two months ago an interesting example occurred in the writer's every-day practice, in which he had furnished a contractor a design for a small building, having panels about 22 feet square. This contractor had handled cement in masonry work for the last 30 years and thought he understood cement thoroughly. The steel was properly placed, the centering well made, the mixture contained the full proportions of cement and in fact the work was done in a thoroughly first-class and satisfactory manner. After the top slab, or the roof, was cast, the weather was rainy for practically two weeks. In the meantime he had placed a cinder fill on the roof which was thoroughly soaked with water, amounting to a load of perhaps 150 or 200 lbs. a foot, and then removed the forms when the work was a little under two weeks old. The concrete was so soft that you could take a pick and drive it into it three or four inches. The slabs from which the forms had been removed did not collapse but they bagged down over six inches and checked so badly that the work had to be removed. Had the reinforcement in this

case been a one-way reinforcement the work would have come down by the run with resulting injury to the men executing the work. After taking out these slabs and recasting them, the contractor in this instance preferred to call the engineer down to look at the work before he tried the experiment of removing the forms a second time and as he could have had the opinion of the engineer by merely asking for it in the first place he had saved himself a little trouble at quite a large expense and could appreciate it fully.

A kind of a false idea seems to have originated among merely theoretical engineers that honest men possessing intelligent views cannot be found engaged in the commercial field, that these men, who have the best opportunity to learn safe and practical methods of construction, would conceal such information for purely commercial reasons and that they are to be distrusted instead of credited when they present them for the general good of the industry at large, by which they make their living. These ethical gentlemen are not broadminded enough to realize that avery failure in the concrete business hurts all engaged in it.

In his preceding remarks the writer has touched on some of the elementary principles of design and the difference in values which may be conservatively used with different types of construction, and his remarks would not be complete without a few suggestions regarding practical methods of pouring or casting concrete and the manner in which serious sources of weakness may be avoided through proper conduct of the work.

The lower portions of the forms should always be filled first. It is not necessary to fill a column by stages. We prefer in all our work to cast the whole as a monolith and pour the concrete over the center of the column until the column is filled to the level of the bottom of the beams. Fill the beams so that the concrete shall flow from the beam into the slab rather than from the slab into the beam and from the column toward the beam rather than from the beam toward the column. Make all splices in a vertical plane, preferably in the center of a beam or in the center of a slab. Failure to follow this method of casting may readily work as follows:

The concrete in the beam will form an inclined plane, sloping toward the column. The seepage, or flow from the beam frequently separates the ingredients of the mix in this inclined plane and layers of nearly clear sand, and then a layer of nearly neat cement and then aggregate, sand and cement will be deposited in the column box, by no means a satisfactory composition for good concrete.

Again, where the concrete is so poured between the spiral and the column box the column fills up faster outside of the spiral, then the mortar will flow into the core and leave the coarse aggregate outside of the spiral and the mortar flowing into the core will frequently close the pores in the outside aggregate and when the forms are removed there will be a layer of fireproofing on the outside of the spiral which can be picked off with the hand; in other words, nearly clean rock. This difficulty is readily overcome by making sure that the concrete is poured over the center of the core and that the flow is from the center of the column toward the outside rather than from the outside toward the center.

The ingredients of which the concrete is composed are sand, cement and stone or gravel, mixed with water, and the last of these ingredients, the water, to secure uniform work, should be as carefully measured as the cement itself. The importance of this remark is little realized by those lacking in experience in this type of construction. A concrete which is sloppy is quite likely to separate and the soup containing the cement and fine sand will readily flow away from the coarse aggregate, whereas if the concrete is mixed with the correct proportion of water so that the mortar is about the consistency of brick mortar, it will flow slowly as a somewhat viscous mass, and this separation will not take place, and the result will be much smoother, better and stronger work than can be secured with either a too sloppy mix or one in which insufficient water has been used. An ordinary tank with a float valve secures absolute uniformity in the water content of the mix.

A long inclined splice in a beam is always a source of weakness, the laitance or inert material of the cement rising to the surface and preventing a suitable bond.

C. A. P. Turner.

Minneapolis, Minn., November 2, 1911.

[The above letter was submitted to Mr. Julius Kahn for any further comments on this subject and we have received from him the following answer.—Ed.]

Sir: The principal reason why engineers have so carefully observed each individual failure of reinforced-concrete construction, lies in the fact that the art itself is comparatively new. We do not manifest any great interest in reading or commenting on the failure of a few steel beams, or a section of a steel or wooden building, as we naturally accept the explanation that such failures are due to gross carelessness. If we were to actually investigate the number of casualties occurring in the construction of steel buildings or of wooden buildings, we would undoubtedly find the ratio as ten to one, as compared with the casualties in concrete buildings, and the risk of erection in conjunction with the steel buildings and the corresponding liability insurance rate is certainly as two to one.

It would be practically a hopeless task for an engineer in designing his steel building, to take into account the safety of the workmen engaged in its erection. His calculations are based upon the fundamental hypothesis of the steel being first-class in quality, and the workmanship fully up to the required standard. If he neglects these, his calculations are absolutely of no avail. If he were to take into consideration carelessness of workmanship or improper materials, and seek to provide for them in his design or calculations, he could not possibly design with economy. Consistent with good engineering, he allows a reasonable factor of safety at all times, but he cannot undertake to exceed this.

The fact of the matter remains that every engineer in steel or wood construction aims only at the perfect strength of his building when completed, and his design is conditional upon the workmanship and the quality of the material being up to he standard upon which to base his calculations. Were he to take into account carelessness of erection or poor grade-of materials, the general loss to owners on this basis would extend into millions upon millins. It is absurd to assume that any type of construction can be undertaken without risk of loss of life, whether it be stone, steel, timber, or concrete, and the actual loss of such life or injury to workmen is very materially less in the erection of concrete than any of the heretofore prevalent methods of construction.

Unfortunately, too much misdirected comment has been made regarding the failure of concrete construction. This is evident if we stop to consider the number of failures which have occurred during the past year. They can actually be counted upon the two hands. They seem glaring only because our engineering periodicals have deemed it their duty to publish accidents, on account of the novelty of the art and their desire to prevent a recurrence. The reader must realize that the amount of reinforced-concrete construction carried on at the present time is enormous. The company with which the writer is connected probably furnishes alone the reinforcement for one substantial building every day of the year, and the work with which he is connected forms probably less than 5% of that which is being done. There is probably used in this country alone between six hundred and seven hundred thousand tons of steel reinforcement for concrete per year. Reinforced concrete is used at the present time for almost every conceivable type of construction, and its general application is so great and the problems of application so varied, that it is safe to say that whoever has no accidents does little work.

Do the occasional accidents, after all, seem material, and do these men who complain of the dangers of reinforced concrete realize the work that is done with it? Do they realize the number and type of engineers and class of builders who are taking part in it? Do they realize that engineers to-day, at this early stage, are probably more expert, utilizing a greater degree of their technical education, than was ever possible for them in other types of construction: that concrete, susceptible to being molded in any form, and steel rods, readily bent in any direction, lend themselves to the perfect theoretical distribution of the material with maximum economy—a situation entirely impossible in structural steel and timber?

When the matter is regarded from this broad standpoint, it seems that every engineer and every engineering journal should strongly advocate and encourage the general use of concrete, realizing that this field offers unlimited possibilities for an enormous variety of work. It offers a field in which the young engineer can enter into a profession or business of his own with very little capital; and which affords him the opportunity of becoming a master in his trade, without being handicapped by the large degree of wealth essential to enter successfully into oher fields of construction, especially structural steel. Stone, sand, cement, and bars can be very generally obtained. His engineering education undoubtedly has taught him the successful combination of these materials, and a comparatively short period of practical education should teach him economical design. These factors, combined with very little capital, enable him to become a reinforced-concrete contractor and make his field of operation just as broad and large as he chooses to have it.

If reinforced concrete, therefore, offers these possibilities for the engineer, it is certainly an art worthy of the greatest possible encouragement. There is absolutely no question regarding the virtue of practically all forms of reinforcement or all systems of design generally prevailing to-day. It is safe to say that a builder, dealing with any of the responsible reinforced-concrete companies, is at least in as safe hands as in other lines; that any of the well-known systems will give him good results if he treats the system rightly. One system attacking another system is the height of fallacy, poor judgment, and poor business, since with the enormous amount of construction going on and the great variety of the applications of concrete, it is certainly quite wrong to assume that any one remedy will cure all ills. A prospective owner can go to almost any company advocating a specific system, and in each case they can point to hundreds upon hundreds of buildings erected with the greatest possible degree of success. When, therefore, any individual stands out and proclaims his system alone as the only one, and all others inferior to it, and usable only with the greatest degree of care, that party had better investigate and familiarize himself with the work done by the other parties. He had better think a while and then grant fully his ignorance of the reality of the situation. There is absolutely no question that both one-way and two-way reinforcement have been used with the most successful results, and that at times one or the other has been most economical, but it is absolute fallacy to state that two-way reinforcement is preferable to one-way reinforcement on account of the special degree of safety given to it. If poor concrete has been used, stressing it in a double direction does not correct its weakness. If anchorage of reinforcement in two directions is highly efficient, anchorage in one direction should be equally efficient since the corresponding steel should be twice as great in quantity and doubly bonded to the concrete. The two-way reinforcement advocate must depend upon good materials exactly to the same extent as the one-way advocate. If material economy can be effected by the use of reinforced-concrete construction in general, a little money can very readily be appropriated to guard for careful inspection. Both one-way and two-way reinforcement are most admirable constructions, as is also flat slab solid concrete, or the reinforced-concrete hollow tile, or the beam and girder, or the cantilever. Each has its place, but all must be carefully designed, must have competent workmanship in construction, and, above all, careful inspection.

The reader must have observed the conspicuous fact that practically all failures to which his attention has been directed, have been sections of roofs, and it is not difficult to realize why the failure should have come in this portion of the building, since the roofs are invariably designed for a small live load, and the actual margin of safety, between the calculated and the ultimate load, is comparatively small. Whereas a factor of safety may mean a great deal when the live load is 1,000 lbs. per sq. ft., it means comparatively nothing when the live load is only 30 or 40 lbs. per sq. ft. Then again, it must be remembered that failures generally occur late in the Fall season or early in the Spring, as invariably in the Fall the constructor rushes his building on to completion, and in his anxiety to finish, fails to appreciate that the setting of concrete is quite materially retarded by the colder weather, and he removes his centering before proper strength has been developed. He disregards the fact that he has only a very small margin of safety to depend on in his roof construction, and as a rsult, a section of his roof fails and falls on the floor below, which, having a larger margin (not factor) of safety, generally holds the fallen loads without failing. Accidents in early Spring are due to the fact that the con-

crete has lain in a frozen condition for a long period, and the frost itself has imparted a superficial and apparent strength, but when the frost disappears and the concrete is subjected to the higher temperature, it thaws, reducing it to an incoherent mass lacking entirely in strength.

Cold weather, therefore, and lack of proper appreciation of guarding against its dangers, are fundamentally responsible for such accidents as have come to our notice. Very largely, however, the general recommendations of a definite constant factor of safety by engineers is responsible. The factor of safety is a misnomer. It is absolutely wrong to insist upon a given like allowable stress upon material for all parts of a building at all seasons of the year. If floors are heavily designed, allowable stresses may be materially larger, and factor of safety proportionately lower, than when floor loads are light. Interior columns should be designed with a greater degree of liberality than exterior or corner columns. Roofs should be designed with a greater load or smaller allowable stresses. Construction during winter months should be handled with greater care than construction to be erected during the summer months. Lightly loaded columns should bear lower fiber stresses than heavily loaded ones.

Appreciating the fact that practically all failures in concrete work occur during the cold weather, engineers should take most special care in the inspection of the work, and thoroughly familiarize the constructor with the additional cautions that must be taken to successfully place concrete at such times. By providing proper enclosure to the forms, and maintaining a fairly even normal temperature by the use of salamander fires, supplemented with the use of concreting materials free from frost, and preferably heated so as to insure normal hardening, there is no reason why concrete construction cannot be continued throughout the cold weather with certain success and at very small additional cost. It is simply a case of the use of satisfactory materials, placed with good judgment and subjected to careful and experienced inspection before the forms are removed.

It is by no means certain that the two-way construction, with its greater ability to deflect, is a better construction than a one-way construction. The shallow floors resulting from two-way reinforcement furnish less stiffness and proportionately greater deflection under safe as well as excessive load, but surely lack of rigidity is not a virtue to be generally encouraged without caution. To begin with, proper anchorage at the ends of beams, girders, or slabs, must exist in good design, and, if this is done, a properly reinforced-concrete beam will deflect as much as a foot or two feet before actual destruction. If, therefore, the beam can deflect so materially, and if anchorage can be made properly in all cases, both one-way and two-way reinforcement can be designed with equal degree of safety, both for the erection stage and for final completion. The one-way presents great stiffness and economy, on account of the material being set on edge; the two-way presents economy on account of the decreased story heights and the double stressing of concrete, but less economy on account of lack of depth. If the concrete or steel in either case is improperly mixed or placed, if the centering is weak or prematurely removed, or if the concrete has been killed by the cold weather—either construction will fail, and the engineer in his design is helpless to guard against it.

Careful inspection must be the engineer's pride. Every concrete building of importance should have an inspector on the work continually. Surely the owner can readily afford the little additional cost of such an inspector when he takes into consideration the fact that he is obtaining a fireproof structure, not inferior but better than a steel structure, at the same or a little excessive cost of the old type of wooden structure. Very few accidents, indeed, are due to improper design, and nine-tenths are due to lack of inspection. The engineer's slogan should therefore be: Better materials and more thorough and expert inspection, and not his continual wrangle about the advantages and merits of one system as compared with another. This most excellent general type of construction is worthy of the most intensified interest and liberal support of the engineering fraternity.

Appreciating the value of more careful inspection, engineers should make a greater effort to familiarize themselves with the methods of determining the quality of the various materials used in concrete work, and be able to intelligently pass upon their quality.

Although there is a general tendency among cement manufacturers to improve the quality of their material, yet this does not relieve the necessity of careful inspection of cement delivered for important concrete work.

The Company with which the writer is connected, realizing the necessity of careful inspection of cement, several years ago installed a very elaborate technical laboratory in connection with its Home Office, to offer services to the various contractors and owners using concrete construction erected under their design.

It is difficult to place a tangible estimate upon the actual good that has resulted from the operations of this laboratory. After experiencing the rejection of a few cars of cement, the manufacturers began to appreciate the requirements for absolute quality on material being delivered for reinforced-concrete work under the inspection of the laboratory, and more careful and conscientious attention has been given to the standard quality of their shipments. It would be a little unfair and uncharitable to the cement mills to state that they would intentionally market poor material, but due to their practical working conditions, there is considerable opportunity for material to leave their plants, which, when subjected to more careful test, is not of approved quality for reinforced-concrete work. The comparatively low price at which cement is being sold has necessarily compelled particularly the smaller manufacturers to press their mills to the maximum output, and it has been observed that in this effort the quality has been in some cases sacrificed.

Engineers should not consider the careful inspection of cement purely as an additional refinement in connection with concrete construction, but as an absolute necessity, and should establish the unconditional rule of not permitting any cement to go into their work until they are fully satisfied by careful inspection that the material is of good quality and capable of giving them the very best results.

The property which the engineer should determine particularly is the perfect soundness of the cement, and to be certain that when the product once hardens it will retain its normal volume and not be subject to internal reactions, tending to cause a retrogression in the strength of the concrete. The fineness should also be carefully watched, as this property is to a great extent a direct measure of the cementing value, and with a well-burnt cement the high adhesive strength is developed by fine grinding that will intensify the activity of the greater proportion of the cement in the processes of solution, hydration, and crystallization that are operative in the hardening.

The quality of the aggregate, is certainly of equal importance to the quality of the cement, and it is to be regretted that engineers have not more generally acquainted themselves with the value of various aggregates, as regards their adaptation for use in concrete work. It is not alone sufficient, in connection with the selection of aggregate, to examine the mineralogical nature of the aggregate to ascertain its hardness and density and freedom from loam and other impurities that would detract from its quality, but greater and more careful attention must be given to the volume and comparative grading. The fine aggregate that is generally considered as sand, should correctly be defined as all material of a diameter that will pass a number four sieve, and should be well graded from coarse to fine, the coarse particles predominating, to ensure the greatest density. The advantage of grading is obvious in minimizing the voids and reducing the actual surface area of the aggregate to which the cement must adhere, as is the case with particles of uniform dimension, which for sand should be avoided. The advantage of grading of the aggregate to contribute density and corresponding strength, applies with equal emphasis to the larger aggregate.

The factor that determines the actual strength of concrete is most correctly the strength of the mortar or binding matrix, and accordingly the greatest care should be taken in the selection of the sand or finer aggregate, to contribute the maximum strength. When a specification requires a 1:2:4 concrete, it is to be understood that the strength of the binding matrix is to be equivalent to the strength of the 1:2 mortar, with a finer aggregate of a granulometric composition mostly perfectly adapted, consistent with practical conditions, to give the greatest strength.

The writer has frequently observed the absolute lack of appreciation of this point, as evidenced by the interpretation of a 1:2:4 specification as equivalent to one part of cement and six parts of inert aggregate, entirely disregarding the volumetric composition. A typical instance to emphasize this important point would occur in the substitution of a natural mix gravel on work requiring a 1:2:4 mixture. Qu invariably the constructor assumes the liberty using six parts of gravel, ignoring the inter ation of a 1:2:4 specification as requiring the ngth of a 1:2 mortar, and that gravel correctl hould only be used in proportion so as to prov two parts of the finer aggregate.

There is unquestionably a great rtunity for engineers to more carefully qualif mselves to pass upon the relative quality of reting materials, so as to be able to determ by ocular examination and simple tests their mparative value for concrete work.

A few words in final conclusion.

Disregard the term "Factor o afety" but study carefully your allowable unit s sses. Vary these to suit the specific needs of the structure as a whole and the parts individuall ive special study to the roof designs, make them stronger than need be. Three failures out of every four in concrete construction occur in sections of a roof, or columns supporting same. Study carefully your columns. A rich mixture of concrete for columns is safer than a specific arrangement of reinforcement. Make your columns $1:1\frac{1}{2}:2\frac{1}{2}$ mixture; a little extra cement amounts to nothing in the total cost of a building. Insist upon careful inspection of your work: request laboratory tests of cement, sand, and stone, and cleanliness of water; caution the superintendent to watch carefully his materials, his erection of forms, and care of removal, the cleaning of forms, especially at the base of each column, proper placing of steel and concrete, bracing of falsework, proper mixing of concrete, thorough stirring or tamping to ensure uniformity and solidity, proper location of stopping places. Instruct him regarding protection of concrete against freezing weather; impress him above all with the absolute necessity of care and conscientiousness in everything that he does, with the importance and responsibility of his position and the fact that he has in charge the safety of his fellow-workmen.

All of the above is mainly a part of good, conscientious inspection, which is fundamentally necessary for all reinforced-concrete work, and should readily be available, if only a portion of the general saving effected is utilized.

J. Kahn.

Detroit, Mich., Dec. 2, 1911.

Resolution Adopted by the National Irrigation Congress, Dec. 9, 1911.

(1) Recognizing the waters of the country as the source of life and the basis of the habitability and productivity of the land, we hold that the waters belong to the people of the country, and that this right of the people in and to the waters is natural, inherent, inalienable, and indefeasible. Recognizing the necessity for administering this invaluable possession of the people by state and federal agencies, we deny the right of state or Federal government or municipal authorities to alienate or convey water by granting franchises for the use thereof in perpetuity, or without just compensation in the interest of the people.

(2) Recognizing the interdependence of the various uses of the waters of the country, we hold that the primary uses are for drinking and domestic supply and for agriculture through irrigation or otherwise in which water is consumed, and that the uses for navigation and for power, in which water is not consumed, are secondary; and we hold that use of the water should be made with reference to all other uses for the public welfare in accordance with the principle of the greatest good to the greatest number for the longest time.

(3) Accepting the fact that all parts of each drainage area are related and interdependent, we hold that each stream should be viewed and treated as a unit from the source to its mouth; and since the waters are essentially mobile and transitory, we hold that Federal control is essential to the equitable distribution and utilization of the waters of interstate streams.

(4) Since the better utilization of our waters for water-supply, irrigation, navigation, and power requires unification of the various administrative agencies of the Government having charge of the Federal regulation and control of water and waterways into a single agency, we request our representatives in the Federal Congress to take early action looking to the creation of an appropriate agency for this purpose; such agency to be empowered to cooperate with states.

(5) Viewing purity of water-supply as essential to the public health and general welfare, we urge on all municipal, state and Federal authorities, and on individuals and corporations, con-

stant vigilance and requisite action looking toward purifying and preventing contamination of the waters.

(6) Recognizing the establishment of the United States Reclamation Service, largely through the efforts of this organization, as one of the important steps in the development of this country as a home for a great and growing people, we heartily favor the continuation and extension of the service; and we reaffirm our full confidence in the integrity and capability of the officers of this branch of the public service.

(7) We express to the Federal Congress appreciation of the provision made at the instance of this organization for a census of irrigation enterprises, and to the Director of the Census hearty appreciation of the manner in which the work was carried out and reported at the Pueblo and Chicago sessions; and we recommend to the Federal Congress and to the Secretary of Commerce and Labor that provision for a similar census of irrigation be incorporated in the law providing for the agricultural census of 1915.

(8) Adhering to the principle of local self-government, we urge cooperation and organization for mutual benefit among irrigators, and advocate provision for irrigation districts by the legislatures of all states in which irrigation is practiced.

(9) We recommend an amendment to Sec. 4 of the Reclamation Act, approved June 17, 1902, such amendment to provide for repaying the cost of any project by the land-owners under it in installments covering a period of not less than twenty years, [instead of ten years, as now provided—Ed.] these installments to be in equal or graduated amounts payable at such time or times as may be determined by the Secretary of the Interior.

(10) We hold that homestead entrymen on lands to be irrigated under any reclamation project should receive patents on making final proof on payment of such portion of the charges apportioned against such tracts as may then be due, under regulations safeguarding the collection of the remaining charges apportioned against such entries.

(11) Holding that a full understanding of the plans, progress and cost of irrigation works on the part of water-users associations will promote good will and harmony between the representatives of the Government and the water users, we recommend that hereafter complete plans and specifications of any work contemplated on any project shall be delivered to the project water-users association before the work begins; we further recommend that itemized semi-annual reports of all charges and expenditures under any irrigation project shall be furnished to the officers of the water-users association under such project.

(12) We favor such administration of the Reclamation Act as shall provide that before any contract for the sale of power developed by any reclamation project is made, it shall first be submitted to and approved by the officers of the water-users association under such project.

(13) We hold that adequate provision should be made for the disposition of seepage and waste waters in irrigable areas under reclamation projects.

(14) Viewing adequate and economical transportation facilities as among the great and growing needs of the irrigable region, we approve the development of navigation throughout the rivers and lakes of the United States in accordance with a comprehensive plan extending to the natural waterways and the necessary canals in the order of their magnitude and commercial importance.

(15) We endorse and commend the Newlands Bill, S. 122, to create a Board of River Regulation, and we urge every delegate to this Congress to cooperate in all possible ways to aid in securing its enactment by the Federal Congress during the present session.

(16) We favor the preservation and development or our national resources by the construction of storage reservoirs by the Federal Government for flood protection, and to save for use in aid of navigation and irrigation the flood waters which now run to waste and cause overflow and destruction.

(17) Recognizing the close natural connection between forests and stream-flow, especially throughout the irrigable region, we heartily commend the Federal forest policy and favor its continuance and extension; and we reaffirm our full confidence in the high integrity and exceptional intelligence of the past and present officers of the United States Forest Service.

(18) Approving the progressive withdrawal of lands suitable for homesteads from the National forests, we hold that such withdrawals should be made in the light of expert investigation showing that the agricultural value of such lands is paramount to their value both for forest production and for stream protection.

(19) We favor the enactment by all states of laws to regulate the cutting of timber on state and private lands, and laws reforming taxation on timber lands, cut-over lands, and reforested lands, to the end that the perpetuity of the forests may be assured and the flow of the stream be preserved.

(20) We approve, and direct our Senators and Representatives in the Federal Congress to support, the Burke Bill (H. R. 14,085) reappropriating and rendering available the lapsed portion of the sum appropriated to provide for the Appalachian and White Mountain Forest Reserves in accordance with previous recommendations of the National Irrigation Congress.

(21) It is the sense of this Congress that in the Federal control essential to the equitable utilization and distribution of interstate streams, recognition must be given to the rights of all citizens who have effected valid rights of appropriation.

(22) We commend the work of the United States Geological Survey, and strongly recommend that more liberal appropriations be made by the Federal Congress and the legislatures of the states for cooperation in the prosecution of the work of the topographic and water-resources branches of this bureau, including stream measurement.

(23) We are firmly convinced that states should exercise thorough and effective, and not merely nominal and perfunctory, supervision over irrigation districts and Carey Act projects, to the end that investors in their securities may have proper assurance of their worth or due notice of their unsoundness. We also urge all Governors and State Legislatures to require public recording of all irrigation enterprises, with accompanying sworn statements as to the priority and amount of water rights, sufficiency of water-supply, total area and general quality of lands, quantity of water guaranteed, drainage works provided, and the financial ability of the owners, promoters and sellers of irrigated land and water rights to fulfill their promises to purchasers; and we hold that the states should provide for examination, under public authority, of all projects recorded, and that reports of such examination should be kept on file readily and easily accessible to prospective purchasers. We also urge the Postmaster-General to supervise advertising matter in the press, and to issue fraud orders prohibiting the circulation through the mails of newspapers advertising unsound irrigation projects and enterprises.

(24) With the view of throwing the weight of the influence of this body against prevalent abuses in the sale of water rights, land, and irrigation securities of the Western states, we recommend that the Board of Governors be authorized to appoint a standing committee to investigate such abuses and the best means of eradicating them; such committee to be empowered to secure and disburse in the name of the National Irrigation Congress any funds needed in the prosecution of its work.

(25) Realizing that the greatest benefits of foreign immigration can be attained only when the immigrants settle permanently on farms, where they quickly develop the spirit of citizenship and help to render this a nation of homes, we commend cooperation among the various state immigration officers and the establishment of common agencies, including expositions and other means of diffusing accurate information, to the end that immigrants may be located on the soil under conditions appropriate to their habits and to the best development of the country as a whole.

(26) Impressed by the wisdom of the founders of this nation who aimed to develop a great people made up of independent land-holding and home-owning families, and realizing that the early standards have largely fallen into neglect so that our population is chiefly urban and wage-earning, we are in sympathy with the recent movement back to the farm; we deplore the holding or controlling of land, or of the water which renders it fruitful, for speculative objects or for other purposes than the making of homes and the maintenance of a strong and vigorous population; and we urge on states and the Federal Government the desirability of framing legislation favorable to home-making, family development, and the industries of primary production rather than the interests of the secondary industries of manufacturing, transportation, merchandising, banking, and other commercial activities.

(27) The National Irrigation Congress, hearing the cry of the people for homes, and for the restoration of individual hope and prospect, hereby calls the states and the Nation to lead the people back to the land; it urges the creation of a bureau of rural settlements to organize communities, not only on the reclaimed areas of the West and South, but also on vacant lands surrounding centers of population. We declare that there is no more wonderful fact than this: that an industrious man can make a living for his family on a very little land. Leadership, organization, instruction, and, in many cases, the loan of credit or capital, are necessary; but all these are within reach of the people through the state and Federal Governments.

(28) Holding that the inclusion of public lands in irrigation districts organized under state irrigation district laws will beneficially extend the operations of such districts and materially aid in the reclamation of arid lands, we recommend to the Congress of the United States the enactment of a law authorizing the inclusion of such lands within such districts, with all the rights, liabilities, and exemptions of lands in private ownership, under proper safeguards of the rights of the United States in its public lands.

(29) We recommend that the Attorney-General of the United States be asked to make a systematic compilation of the irrigation laws of the various states and to secure the publication thereof for public distribution; and we urge that the respective legislatures of the various states enact uniform laws relating to irrigation and to other uses of the waters connected with irrigation.

(30) We commend the irrigation and drainage investigations of the Office of Experiment Stations, the soil and water investigations of the Bureau of Soils, and the dry-farming investigations of the United States Department of Agriculture, and equally commend the work of the Agricultural Experiment Stations and Engineering Departments in the several states; we favor further investigation of natural sub-irrigation and of irrigation by pumping; and we urge more liberal appropriation by the Federal Congress and by the states for the work and cooperation of these agencies, and for the more general distribution of the reports and bulletins recording their operations and results.

(31) Since there are in the United States some 75,000,000 acres of swamp and overflow lands virtually unoccupied; since the drainage of these lands will promote the public health, render a vast area available for agriculture, materially aid navigation, and add greatly to the wealth of the nation; and since the reclamation of these lands is a public duty affecting the general welfare, we urge the Federal Congress to enact such laws as may be necessary to reclaim and make useful the swamp and overflow lands and ensure their highest development; and we especially recommend the creation of a national commission to make the necessary surveys, estimates of cost, and plans for such reclamation in cooperation with individuals, communities, corporations and states.

(33) Since drainage ditches or canals used in connection with irrigated lands greatly enhance productivity, we strongly urge Governors and State Legislatures to provide for such drainage districts as may be required for the best development of sections in which this form of water control is necessary.

(33) It is the sense of this Congress that Federal and state departments in charge of reclamation and conservation work should make accessible to the press the legitimate news of such departments as their work develops, to the end that the people may be informed rapidly and widely as possible on these important subjects.

(34) Since the Dry Farming Congress is working in the interest of scientific soil tillings and conservation of moisture in order to reclaim all possible arid land by saving and utilizing all the available water, this Congress extends hearty wishes for the success of that organization, with the assurance that we appreciate the value of every step that will in any way result in placing a greater area of land under cultivation.

(35) Since the expert knowledge of officers of the Reclamation Service has in the past been invaluable to the Congress at large, and especially to the Resolutions Committee, we recommend that the Secretary of the Interior be requested to detail the Director of that Service, and such other officers thereof as may in his judgment be competent, to attend all sessions of the Congress and hold themselves in readiness to give necessary information of public character to the Resolutions Committee.

Drawings for the Pattern and Core-Box of a Francis Turbine Runner.

By GEO. M. PEEK.*

It is not the intention of the writer to go into the theory of the design of a Francis turbine in this article but to try to fill a vacancy which seems to appear in treatises on turbine design, at least those which are written in English, namely, the practical layout and construction of working drawings for the runner. The theory of the construction and methods for calculating the water-passages and the velocities at the different points have been explained by other writers,† but all previous treatises are lacking from a practical standpoint. It is the object of this article to go into the practical side of the question and put the matter in such shape as will enable the young engineer or draftsman to use this article as an adjunct to the theory, which he can get from other sources, in laying out a runner in such a shape that a first-class pattern-maker may be able to follow the drawings and make the pattern and core-box.

It should be understood, to begin with, that the drawings will be used directly for cutting out templates, and therefore it is necessary to use the proper pattern-maker's rule according to the metal of which it is proposed to make the runner and the drawing should be made full size.

The angle between the bucket entrance and a tangent to the runner circle may be anything from 60° in a low-speed turbine to 135° in a high-speed, but for the purpose of this article it will suffice to show the construction for a medium speed or normal runner, which has the buckets radial where the water enters them. The exit end of the bucket is the part where particular care should be given to the shaping and design.

In laying out a turbine runner, it is customary to divide it up into a number of partial runners. In Fig. 1, the curve aa_1 may be considered as the intersection of the surface of revolution, which forms one crown of the runner, with the plane of the paper. The curve ee_1 the intersection of the surface of revolution, which forms the other crown, with the plane of the paper. The partial runners are represented by the parts contained between the curves aa_1 and bb_1, between bb_1 and cc_1, between cc_1 and dd_1, and between dd_1 and ee_1. Thus the runner is divided into four partial runners.

The simplest way to lay out a runner is so

*34 East Grand Ave., St. Louis, Mo.
†See Eng. News, Jan. 6, 1910, p. 20: "A Rational Method of Determining the Principal Dimensions of Turbine Runners," by S. J. Zowski.

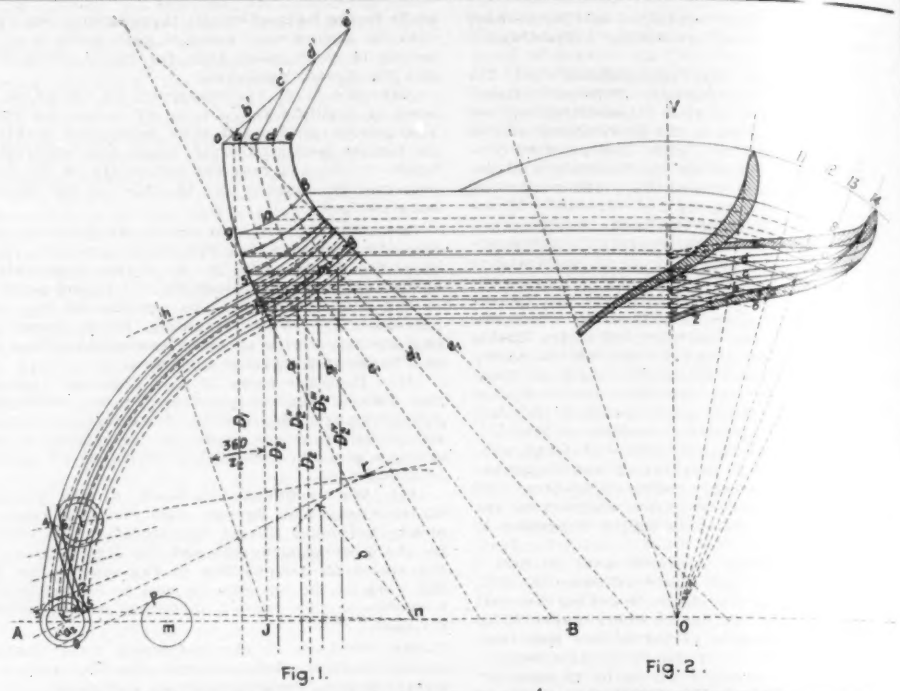

Fig. 1. Fig. 2.

FIGS. 1 AND 2. ELEVATION AND SECTIONAL PLAN OF A MEDIUM SPEED FRANCIS TURBINE RUNNER, SHOWING DRAFTSMAN'S CONSTRUCTION LINES.

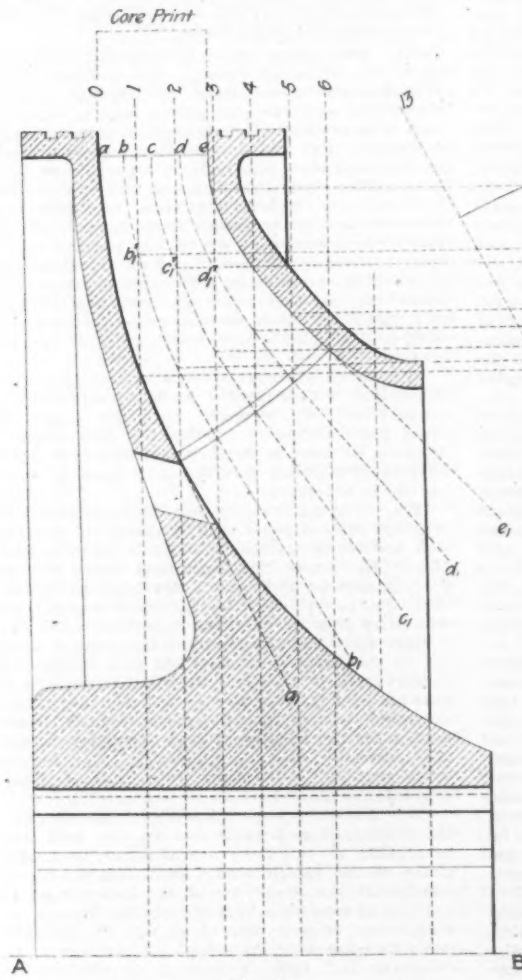

Fig. 3.

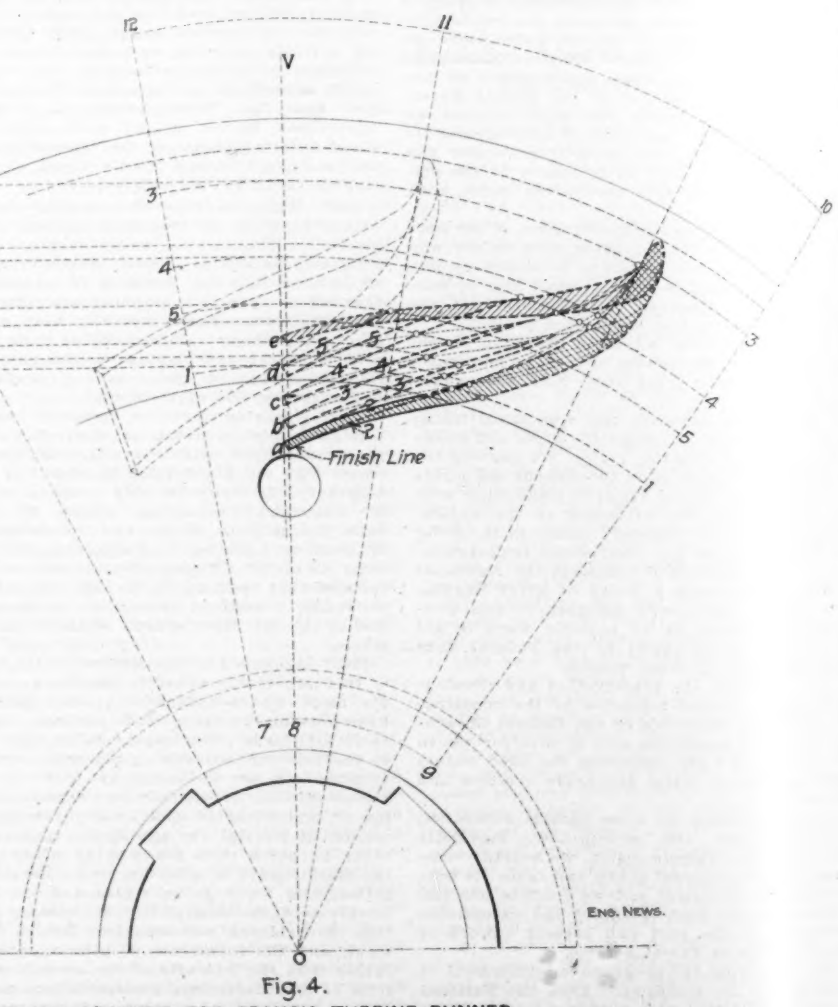

Fig. 4.

FIGS. 3 AND 4. PATTERN DRAWING FOR FRANCIS TURBINE RUNNER.

that the discharge edges of the bucket vanes are in a radial plane, that is, so that they terminate in a plane which passes through the axis of the runner. Such a bucket is shown in Fig. 2. If the discharge edges of the buckets of our four partial runners terminate in a radial plane, the curve drawn through the center of the discharge openings will lie so close at all points to a radial plane that for all practical purposes it may be assumed to lie in such a plane. Since the curve fg (Fig. 1) is such a line it will be seen in its true length, and it will be the length of the discharge opening.

The points b, c and d, Fig. 1, may be determined as follows: The curve fg, the length of which is gotten from calculation, is divided into four equal parts, to locate the points of intersection with the curves bb_1, cc_1 and dd_1. The line ae' is drawn at random; ab' is laid off to any convenient scale proportional to D'_2, where D'_2 is the diameter to the center of gravity of that part of fg intercepted between the curves aa_1 and bb_1; $b'c'$ is proportional to D_2''; $c'd'$ is proportional to D_2''', and $d'e'$ is proportional to D_1''. Join ee' and draw parallel to this the lines dd', cc' and bb'. The entrance to the bucket is divided up in this manner so that the entrances to the partial runners will be such as will admit the same proportion of the total amount of water passing through the runner as will be discharged from the corresponding partial discharge openings. When fg is divided into equal parts, a greater amount of water will be discharged from the partial runner dd_1, ee_1 than through the others owing to the fact that its discharge opening is farther from the axis than the others.

The curve fg is normal to aa_1, bb_1, cc_1, dd_1, and ee_1, and since these lines are drawn as nearly as possible to correspond to the threads of the water as it passes through the runner, this curve will represent the intersection of a surface, which is normal to the flow of water, with the plane of the paper. Since the curve fg is normal to the stream lines, the product of the length of this curve with the normal width of the opening between two vanes forming a bucket will be the discharge area of the bucket.

In order to develop the vane of a bucket and show the intersection of the vane with the crown of the runner, the intersection of which with the plane of the paper is represented by the curved line aa_1, we proceed in the following manner. At the point f it may be assumed that the crown of the runner coincides with the conical surface generated by the line fn when revolved about AB. Then the distance center-to-center between the discharge openings of two buckets, measured on the developed conical surface, would be fh (Fig. 1), where the angle $hNf = 360°/z$, z, being the number of buckets in the runner.

With n as a center and nf as a radius draw the arc flk. Make $kl = hf$ and draw circles at k and l whose diameters are a_1 = width of the discharge opening of the bucket. Draw also the circles whose diameters are $a_1 + 2s$, where s is the thickness of the bucket vane at the discharge end. At m on the line AB, where $km = kl$, draw a circle whose diameter is $a_1 + 2s$. Draw the common tangent op and parallel to this tangent, through k, draw kr. With n as a center draw the circular arc tangent to the line kr and through l draw a tangent to this circular arc. Then the point r at the intersection of these tangents will be the center for drawing the working face or front of the bucket vane ($s6$) on the developed conical surface. While the location of this point is not mathematically exact it is as nearly so as the accuracy of a careful draftsman warrants. The back 1, 4 is drawn by gradually increasing the thickness of the vane so as to make the adjacent sides of two successive vanes parallel for a short distance at the discharge opening and thereby give a definite direction to the water as it is discharged from the runner.

The next step is to revolve this developed part of the vane back into the line nf and then finally project it over to Fig. 2. In Fig. 2 it will be observed that the arc 3, 4 is equal to arc 3, 4 in Fig. 1. In a like manner other points on the vane may be projected over to Fig. 2. This process is repeated for each of the curves bb_1, cc_1, dd_1, ee_1. These projections are shown in Fig. 2, but the work necessary to produce them is not shown in the figure, in order to avoid confusion.

We now have the projected elevation of the discharge end of the vane and it will be necessary to sketch in, by eye, the remaining part of the vane as shown in Fig. 2. It may be found necessary to change the results of the first attempt at drawing in the remaining parts of the projection and this may be tested by circular projection. If in Fig. 2 we assume the vane to be cut by a plane normal to the plane of the paper and represented by the line O, 13 then project the intersection of this plane with the vane by circular projection to the line O, V then back over to Fig. 1, which is shown by the curved line 8, 10, 9 (Fig. 1). Had the vane been sketched in so that this curved line would not have been smooth as shown, it would have been necessary to change it so as to make this curve smooth and not have humps and irregular places in the vane. This test should be applied to a number of places in the vane in order to insure a vane with a proper surface.

The next step in the process is to make a drawing from which a pattern-maker can construct the pattern and core-box for making the runner. This is shown in Figs. 3 and 4.

Fig. 3 is the same as Fig. 1, except that the runner crowns are completed and the runner is shown as being intersected by planes normal to the plane of the paper. The distances between these planes represents the thickness of the boards used for building-up the core-box for making the cores used in casting the runner. The pattern itself would be turned up solid with the continuous core print around its periphery, as shown. Of course the water packing grooves, although shown on the drawing, would not be turned in the pattern.

Fig. 4 is the same as Fig. 2 with the addition of the intersection of the bucket vane with the planes represented by the straight lines 0, 1, 2, 3, 4, 5, 6, 7 and 8 in Fig. 3. These intersections appear in Fig. 4 as curved lines. The numbers on the curves correspond with the numbers on the lines representing the planes in Fig. 3.

All of the above work, as already noted, is done with a pattern-maker's rule, so that templates may be cut out by the drawing and the pattern-maker can use these templates to form

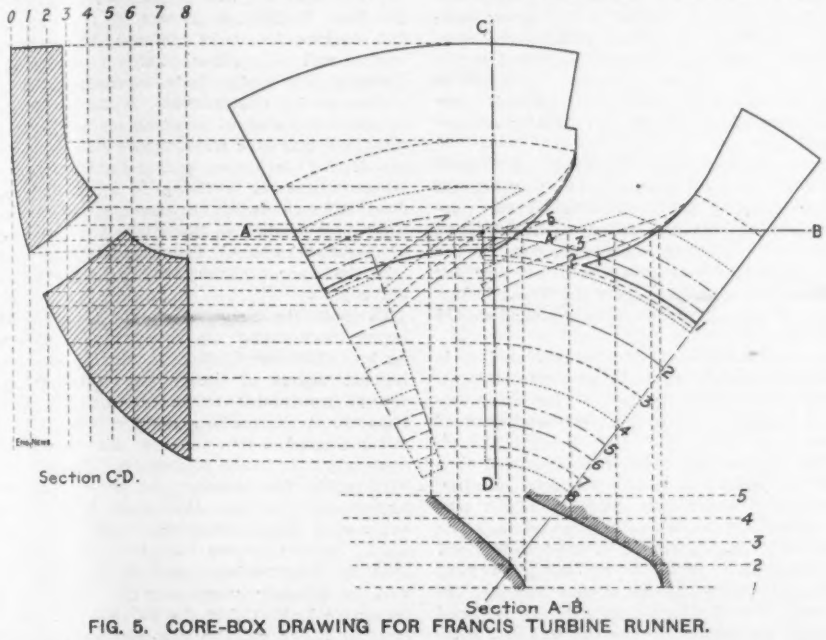

FIG. 5. CORE-BOX DRAWING FOR FRANCIS TURBINE RUNNER.

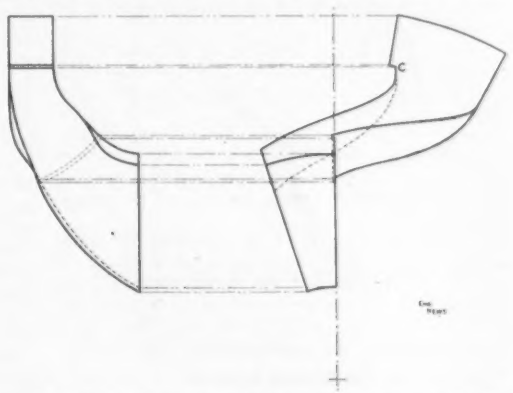

Fig. 6. Plan and Side Elevation of Completed Core for Turbine Runner.

the boards used in building up the core-box. The boards, after being cut to template, are glued and screwed together and the surfaces finished down so that one edge of each board forms a part of the finished surface. The boards as they would appear when put together are shown in Fig. 5 without a top or bottom. The top and bottom of the core-box would have the shape of the crowns, as shown in Fig. 3.

Fig. 6 shows two views of a finished core and it will be noted that the cores are squared out at C so that the bucket vane when cast will have a thickness of metal such as will insure a solid casting and to allow for finish. It is, of course, not necessary to make the drawing shown in Fig. 6, but this was added in order to give the uninitiated an idea of the appearance of a finished core. I might add that in making a working drawing all of the work described would be done on one drawing.

The Relation of Railways to Water Pollution, from a British viewpoint, is thus expressed by Mr. G. Bertram Kershaw, in his recent book entitled "Modern Methods of Sewage Purification:"

It must not be forgotten that many railways, upon which long distance trains are run, provided with lavatories, are to all intents and purposes elongated sewage farms, and that the drainage from the ballast of the permanent way, and the solids removed thence and thrown on the embankments by the platelayers, are washed during rainfall into the drains and water courses adjoining the line, and thence into the rivers and streams of the locality.

The Pacific Entrance of the Panama Canal through Panama Bay will be covered by a hydrographic survey with wire drag during the next few months. The work will be done by a United States Coast and Geodetic Survey party under Mr. N. H. Heck, Assoc. M. Am. Soc. C. E., who has had charge of the wire drag work of the Survey for the past seven years. An area of about 60 sq. miles will be covered so that when the work is completed the Government will be able to guarantee that the charts show every shoal in the entrance channels above 45 ft. below the mean of lower low waters. This will insure a safe channel for the largest steamships now in use. The floor of Panama Bay is somewhat rugged and a more thorough hydrographic survey than can be obtained by sounding will be of great value. The method of wire drag work of the U. S. Coast and Geodetic Survey was described in Engineering News, of Dec. 1, 1910, p. 583.

Meeting of the National Association for Preventing the Pollution of Rivers and Waterways.

In February, 1910, a few engineers and other sanitarians met in Washington, D. C., for the purpose of requesting President Taft to appoint a federal commission on water pollution. The delegation was sympathetically received but was told that Congress alone had power to appoint such a commission. President Taft further advised his callers to organize a private association to consider the subject. Accordingly, there was organized the National Association for Preventing the Pollution of Rivers and Waterways. Mr. Calvin W. Hendrick, Chief Engineer of the Sewerage Commission of Baltimore, Md., the leader of the movement, was elected chairman of the association and Mr. H. de B. Parsons, of 22 William St., New York City, was chosen as secretary and treasurer. Since the date mentioned, several meetings have been held and the membership of the association has been extended by correspondence.

On Dec. 13, 1911, a meeting of the association was held at Baltimore, Md. The forenoon was devoted to general business, the afternoon to a visit to the Baltimore sewage purification works (just put in operation), and the evening to the presentation of papers. About twenty members and guests were present at the business session and a much larger number listened to the evening addresses.

It would be difficult to say whether the proceedings as a whole showed a greater desire to prevent water pollution or to ensure that the anti-pollution campaign now being waged in many parts of the country be conducted on a scientific rather than a sentimental basis.

Business Session.

President Kendrick outlined the history of the organization and stated that one of its chief objects is to secure a few thoroughly representative members in each state, who will aid in obtaining adequate state and interstate legislation for the prevention of water pollution. Secretary Parsons reported 56 members in 22 states and the District of Columbia, and a respectable cash balance in the treasury. During the convention a half dozen or so additional members were elected.

After discussion and amendment, the constitution and by-laws drafted by a committee during the past years were adopted. The object of the Association, as stated by the constitution, is to make a study of and to gather information concerning the pollution of rivers and waterways in the United States; to awaken public interest therein so as to bring national and state legislation and executive bodies to a realizing sense of the importance of this question and to the necessity for a comprehensive and consistent system of legislation in regard thereto. The annual meetings of the association are to be held in October, November or December, as the executive committee may decide.

Mr. Kendrick was re-elected as president and Mr. Parsons as secretary and treasurer. Mr. Rudolph Hering, New York City, was chosen first vice-president, and Brigadier-General Geo. H. Torney, Washington, D. C., as second vice-president. The executive committee will consist of the four officers just named, and Messrs. Geo. M. Wisner, Chief Engineer of the Sanitary District of Chicago; Prof. Edward Bartow, Director Illinois Water Survey, Champaign, Ill.; and X. H. Goodnough, Chief Engineer Massachusetts State Board of Health, Boston, Mass.

At the suggestion of Dr. Ira Remsen, President of Johns Hopkins University, a general discussion of water pollution and its prevention and of the aims and policy of the association took place. General Torney stated that the War Department has recently been taking a stand against water pollution, and has been building plants for its protection. Dr. C. F. Stokes made a similar report for the Navy. He said that incinerating plants are being put in on ships and will be constructed at ten contagious diseases hospitals on shore; at the latter, as we understand, excrement will be burned. The Navy is also building a sewage disposal plant at a station near Chicago. Major Frederick F. Russell told of a model sewage disposal plant being built by the War Department at Fort Sheridan, near Chicago, Ill. Messrs. A. C. Abbott, of Philadelphia, Henry P. Walcott, of Boston, and Edward Bartow, of Illinois, mentioned work being done in their respective states, Dr. Walcott contenting himself with the remark that Massachusetts began the study and control of sewage disposal and water pollution no less than twenty-five years ago.

President Kendrick, after questioning some of the speakers connected with the federal government, drew the conclusion that the association had prompted or furthered the action of the government, and expressed satisfaction with the fact that the national government is at last setting an example to the states and cities.

Mr. George C. Whipple, of New York City, gave the discussion a turn by saying that the public ought to be informed that the water-supply problem cannot be solved by purifying sewage. He expressed the belief that many cities are spending money on sewage treatment which might better be devoted to water. It would be well to get together data which would show just what sewage purification is really accomplishing.

Dr. A. J. McLaughlin, of the U. S. Public Health and Marine-Hospital Service, remarked that after traveling for 14 months for the purpose of studying water pollution he had learned that there is too much sentimentalism on the subject. Thousands of people are howling for the exclusion of all sewage from the Great Lakes. The value of sewage disposal by dilution should be recognized.

Mr. George M. Wisner, of Chicago, said it is impossible to exclude all pollution from streams. The thing to do is to determine how much exclusion is needed to meet the local conditions of each case.

Mr. Rudolph Hering, of New York, urged that a distinction must be made between pollution which menaces health and pollution which creates a nuisance—offence to eye or nose. The needs of each case must be clearly understood and acted upon, and it is necessary to keep within the financial means of the people. He agreed with Mr. Whipple as to the unbalanced expenditure, too much for sewage and too little for water purification. Practically all European countries purify all surface waters, leaving stream pollution a matter of nuisance prevention, merely.

Mr. X. H. Goodnough, of Boston, remarked that in Massachusetts, during the past twenty-five years, each stream [and he might have added each city problem] is considered on its merits. Just how much can be done to prevent pollution is an eminently practical question, especially in view of the fact that when a case is taken into court proof of the existence of a nuisance is necessary if the suit is to be won. One thing the association might do is to take up the question of what constitutes a reasonable degree of pollution.

As to manufacturing wastes, it is often difficult to decide how much expense a manufacturer can stand to prevent pollution by these without becoming financially embarrassed. Mr. H. W. Clark, of Boston, called attention to the fact that at Lawrence, Mass., 70% of the pollution of the Merrimac River is contributed by factories, and only 30% by city sewage.

Mr. Whipple moved that the chair be instructed to appoint a committee of five, on Standards of Purity for Rivers and Waterways, to make a broad study of the subject and to submit to the next meeting of the association a tentative scheme for standards. This motion was adopted, but the committee was not announced during the convention.

Visit to Baltimore Sewage Purification Works.

Baltimore is just on the point of losing the distinction of being the only city of size in the United States without sanitary sewers. For years it has had storm sewers, but it waited until the twentieth century before building sanitary sewers. Ninety miles of the latter are ready for use and house connections to them are now being made. A sewage purification plant designed to treat the sewage of some 275,000 people is ready for use and its units will go into operation as soon as the making of house connections demands. It is expected that contracts will be let in 1912 for doubling the capacity of the sewage works.

As the disposal works now stands, there are three hydrolytic tanks, 120 ft. wide and 450 ft. long; three sludge-digesting tanks, 120 ft. wide and 200 ft. long, twelve acres of sprinkling or percolating filters, and two final sedimentation tanks. The sewage is screened twice. It passes through coarse iron screens or inclined gratings before it enters the hydrolytic tanks and through fine revolving screens, placed between these tanks and the percolating filters. At full capacity, the sewage will be retained eight hours in the hydrolytic tanks, and will be applied to the filters at the rate of 2,500,000 gals. per acre per day. Sludge pumps will lift the sludge from the hydrolytic tanks to the sludge-digesting tanks, and still other pumps from the sludge tanks to the sludge beds, consisting of 3 ft. of coarse sand, underdrained. Hydroelectric power to pump the sludge, to fill an elevated tank with treated sewage for flushing the sludge tanks and the filter underdrains, and to light the plant will be generated by utilizing 18 ft. of fall in the final effluent, before it passes from the works through a conduit to Back River, a sluggish arm of Chesapeake Bay. The effluent will be carried into the river through 2,500 ft. of banded wood stave pipe.

To meet the requirements of the State legislation authorizing the construction of sewage works (which requirements virtually called for the highest degree of purity known to the art of sewage treatment), it was originally intended to supplement the tanks and filter beds with intermittent sand filters, should this be considered necessary. In place of these beds, provision has been made for treating the filter-effluent with hypochlorite, in the final settling tank, should experience demonstrate the need. The consensus of opinion among engineers, as far as gathered by Engineering News, is that disinfection will be entirely unnecessary. There is every reason to believe that the effluent from the final settling tanks will be non-putrescible, in which case it can create no nuisance in the "river." The only possible menace to health is through the carriage of pathogenic germs by the effluent through eight miles of sluggish "river" water, and then six miles further to oyster beds in Chesapeake Bay.

The sanitary sewers, the purification works, and extensions to the storm sewers have been carried out by the Sewerage Commission of Baltimore, with Mr. Calvin W. Hendrick as chief engineer.

Papers at the Evening Session.

Four papers were scheduled for the evening session. One of these, by Mr. John D. Watson, Engineer of the sewage works of Birmingham, England, was not read (the author not being present), but will be printed in the Proceedings of the Association.

THE SEWERAGE QUESTION FROM A MEDICAL STANDPOINT.—Prof. Wm. H. Welch, of Johns Hopkins University, and President of the Maryland State Board of Health, presented a scholarly paper on this subject. In opening, he said that sewerage, like other sanitary questions, has largely passed out of the hands of the medical profession into those of sanitary engineers. He then reviewed the scanty knowledge which we have of the conceptions of sanitation possessed by ancient and medieval peoples, remarking that extant Greek writings contain less than do the Hebrew on this subject. The first real beginnings of a conception of sanitation date from the 30's of the nineteenth century, when Dr. Southwold Smith imparted to Edwin Chadwick some ideas, imperfect though they were, on the relation between filth and disease. The great weakness or error of these ideas was

their failure to recognize the individual as the source of infection.

After dwelling on more recent developments in sanitation, Dr. Welch remarked that it is difficult to say just what effect improved means of sewage disposal have upon health. The evidence indicates, he said, that the general death rate and also the mortality from tuberculosis is reduced thereby. He understood that sanitary engineers now hold it to be unreasonable to demand that sewage be so purified that it may be discharged with safety into streams used for water-supply. He confessed to disappointment over the evident conclusion of engineers that safety against sewage is up to the water engineer rather than the sewage engineer.

Finally, Dr. Welch spoke of the necessity of having sanitary engineers attached to local and state health departments—remarking that this is one of the greatest present needs of the Maryland Board of Health—and urged that the association do all in its power to secure the creation of a federal department of health.

THE SEWERAGE STATUS IN THE UNITED STATES.—Mr. H. de B. Parsons, secretary of the association, in the opening portion of his paper on this subject, remarked that natural drainage areas and political or governmental areas do not coincide, hence lawsuits over water pollution result. These suits will continue and increase unless some cooperation to remove or lessen their cause is effected. The suits may lead to a federal constitutional amendment giving the government control over water pollution.

On the basis of certain typhoid death rates for European and American cities, the author concluded that the American rate is 18 per 100,000 population higher than the European rate (23½ to 5½) and from this he deduced a yearly loss, due to this excess rate, of $81,000,000, valuing each life at $5,000.

Besides state cooperation against water pollution, Mr. Parsons suggested a federal standard of pollution, with government supervision for its enforcement. He also suggested that the Congress of Governors might serve as a forum for discussion of pollution and a means of securing uniform legislation against it.

PRACTICABLE POSSIBILITIES IN THE PURIFICATION OF DOMESTIC SEWAGE.—This topic was ably presented by Prof. C.-E. A. Winslow, of New York City. Prof Winslow's final remarks formed a particularly fitting conclusion to the whole convention, since they turned the attention of all present, as it had already been turned more than once during the morning session, to the need of a rational and scientific rather than a sentimental and wholly impracticable viewpoint for considering the nature of the water pollution problem and the proper direction and extent of the campaign against it.

At the start, the author stated that the lead in sewage disposal was held by the British from 1860 to 1890, by the Americans through a considerable portion of the 90's, by the British again from the late 90's for some ten years or so, and now for a few years past by the Germans.

The legitimate character and great importance of sewage disposal by dilution was touched upon. After speaking of the Imhoff tank and its promises for the future, surprise was expressed over the great attention the tank has been given in the United States as compared with the scant attention given here to the Dibdin slate beds. Prof. Winslow also spoke of the apparent strange overlooking, in the eastern United States, of the good results obtained by Alvord and others in the middle west from carefully-constructed intermittent sand filters, operated at relatively high rates.

Speaking of laying overmuch stress on sewage purification, where the protection of water-supplies is involved, Prof. Winslow said the choice may be between destroying 100 bacteria by sewage purification works against only 1 by water purification. In certain cases, the bacterial purification of sewage may be necessary, as when the sewage outlet is near a water intake or oyster beds. In such cases, intermittent sand filtration will give a high degree of purity, but reliance cannot be placed on contact beds or percolating filters. Reliance can be placed on bleaching powder, or calcium hypochlorite. In fact, the engineer can now meet any sewage purification condition with which he may be confronted.

Finally, Prof. Winslow laid just emphasis on the fact that sewage disposal is only one of many problems confronting the modern city, and should not be unduly considered to the neglect of such health problems as the purity of the milk supply and the reduction of infant mortality.

The Life of Wrought-Iron and Steel Service Pipes: A Discussion Before the New England Water Works Association.

At the December monthly meeting of the New England Water Works Association, held at the Hotel Brunswick, Boston, Dec. 13, slumbering disputes over the merits of wrought-iron and steel pipe, respectively, were revived for the edification and instruction of these water-works officials.

As a fitting opening to the discussion, Prof. W. H. Walker, of the Massachusetts Institute of Technology, presented an informal paper entitled "An Investigation of the Relative Life of Iron and Steel Pipe, as Found in Actual Service." The title of the paper described a part of the remarks only, as Prof. Walker devoted the most of his time to an explanation of the attack of iron and steel by water. This was a most instructive though popular explanation of the multitude of phenomena entering.

He reviewed the now generally accepted explanation that iron goes into solution naturally in water, hydrogen is deposited in a film on the iron and that, for the process to continue sufficient to have an appreciable attack of iron with the formation of rust, the water must contain a supply of dissolved oxygen to remove the intervening hydrogen film and to oxidize the dissolved iron. He explained the effect of mill scale, copper, etc., in accelerating the corrosion of iron by their property of permitting the discharge of hydrogen from their surface in a way that was not possible with iron. How this was done he could not explain beyond the statement that "the Lord made it so." He explained the function of zinc in protecting iron from corrosion from its property of going into solution easier than iron, showing how it served at its own expense and for a limited radius.

Studies made at the Massachusetts Institute of Technology were mentioned which had shown that it was feasible to remove the dissolved oxygen from water (running often as high as 20%) by preheating in open tanks where the water could be treated not under pressure.

Prof. Walker took occasion to condemn any accelerated tests for the probable service life of iron and steel so far as they had yet been developed. The uselessness of acid tests he explained as being on account of the very different conditions that were produced by the rapid solution of the iron, with the consequent deposition of hydrogen with such rapidity that it streamed off in bubbles. Under natural conditions of corrosion the hydrogen is deposited, but so slowly that it adheres to the iron until combination with dissolved oxygen.

In making corrosion tests under as near normal service conditions as can be reproduced, certain precautions were outlined as necessary. (1) Specimens compared must have the same size since researches have shown that a larger piece corrodes less rapidly, in proportion, than a small piece, on account of the greater proportion of edge to area in the smaller piece. The access of dissolved hydrogen is more ready at the edge. (2) The conditions of exposure of iron to water must be fixed; that is, the depth of immersion must be the same in two cases which are being compared, and the rate of flow of water past the specimens must be the same. It has been found that increased flow up to a certain point increases corrosion, but, after that maximum point is reached, added velocity past a specimen actually decreases the rate of corrosion, and very markedly.

Under the auspices of the Massachusetts Institute investigations were carried on in New England to locate cases where steel and wrought-iron pipes were connected next to each other in different kinds of water lines. Wherever it was possible these were taken out and cleaned with ammonium citrate (a salt which possesses the property of dissolving the rust without attacking the metal). The pits were measured and the character of the corrosion was noted. Out of 64 cases, the wrought-iron pipe was found worse than the neighboring steel pipe in 20; steel was found worse than its wrought-iron neighbor in 18 cases; there was no difference in 9 cases, and no corrosion at all in 17 cases.

Prof. Walker called attention to short life which was being found in many installations through the use of light-weight steel pipe of a given nominal size. This arose through the multiplicity of uses which had been found for steel pipes compared with wrought-iron, which was still made only in the heavier weights.

Mr. F. N. Speller, of the National Tube Co., Pittsburgh, presented the case of the steel pipe. Although he added little data to that found in his recent paper, printed in Engineering News, March 23, 1911, the company with which he was identified had carried on similar investigations to those mentioned by Prof. Walker, except that they were located at different parts of the country. The results were entirely in accordance with those found in New England. He repeated the familiar argument that the presence of cinder in wrought-iron pipe should tend to accelerate the corrosion on account of its not being a complete envelope and acting much like mill scale for the easy discharge of hydrogen. He called attention to the need of distinguishing between modern steel pipe and that of early manufacture, on account of the much greater homogeneity secured in the last few years.

Mr. Geo. Schuhman, of the Reading Iron Co., Reading, Pa., took up the cudgels for "good old-fashioned wrought-iron pipe" in a homely and entertaining way, which has made his remarks on this subject always interesting, if not novel. He described the old-fashioned way of puddling pig-iron, rolling, etc., and called attention to the need of knowing whether one was buying "old-fashioned" wrought-iron pipe or a wrought-iron pipe made from steel junk which might contain steel of all qualities and alloys. Such a pipe as the latter, of course, would be expected to corrode worse than either steel or good wrought-iron. He showed micro-photographs of samples of wrought-iron pipe, magnified to 200 diameters, to refute the claims of the steel-pipe men that the envelope of cinder and slag was not complete around a fiber of iron. This cinder, he claimed, produced a slight skin of silicious material very similar to that skin on cast-iron which may account for the resistance of that material to corrosion.

Both Mr. Schuhman and Mr. Speller described the attempts of their concerns to develop a method of branding pipe which they manufacture, to ensure the ultimate purchaser's getting the desired material. They found no difficulty in branding lap-welded pipe on account of the mandrel against which the seam was pressed. In butt-welded pipe the branding had not been accomplished satisfactorily on account of the absence of the mandrel. If a depression is made for the name, then leaky threads are apt to result if the pipe has to be cut at a brand, as might easily occur. If the name is raised then the brand has to be filed off in such a case before the pipe can be threaded, which causes trouble. Both expressed confidence, however, that they would be able eventually to evolve some scheme of branding which would allow identification of the pipe on close examination.

The three principal speakers' remarks were discussed at considerable length by different members of the Association, who explained their preference in many cases for wrought-iron pipe on account of the greater success they found under usual conditions in threading pipes. A

number of men who had had experience with both wrought-iron and steel pipe gave practical corroboration of the investigations of Prof. Walker and Mr. Speller. A few, however, were strongly of the belief that wrought-iron was more resistant, and many more were using wrought-iron pipe on account of the certainty of getting a pipe of heavier weight of the same nominal size.

Grouting the Porous Foundations of a Dam.

In connection with the current discussion relative to the effect of porous percolation on the base of a masonry dam, which has been renewed on account of the failure of the Austin, Pa., dam, it is interesting to note briefly a construction now going on in this country where an attempt

FIG. 1. UNWATERED SECTION OF HALE'S BAR DAM COFFERDAM.

is being made to improve a very porous foundation of a dam by pumping grout into drill holes driven through the clear rock bottom. The two half-tones reproduced herewith show the general nature of the work, which is at the Hale's Bar Dam across the Tennessee River. This dam is now being built in connection with a hydro-electric project which is being financed by private capital but which is under the general supervision of the Federal Government on account of a required provision for a navigation lock at the end of the dam.

Both lock and dam are founded on a limestone rock, which is full of seams, many of them badly worn and eroded by the action of water. These seams are filled with mud and gravel and in some cases by a clay deposited in past ages. The seams are evident on the surface and extend many feet down into the rock. At the beginning of the work leakage through them proved a source of great delay. In order to control the leakage, and also to provide a foundation through which there would be no percolation, it was decided to sink drill holes all over the footing and to pump them full of a grout. In sinking these drill holes it has been discovered that not only are there seams evident on the surface, but the subsurface of the rock is interspersed with many cavities and caves which offer passageway for the water.

It was intended to lay the bottom dry in a succession of cofferdams, but the leakage was so great that it was found impossible to unwater some of the dams. In these cases well drills were floated on barges and a number of holes drilled to receive a 2-in. pipe. These pipes were then carried up above the water level and grouting begun. In some instances it was necessary to blow out the collected mud in the subterranean cavities, but in all cases after the seams or cavities were clear, grout was pumped in under a pressure of from 5 to 10 lbs. When the pipe refused further charge it was capped and the operation repeated on other pipes.

Fig. 2 is a view of the power-house pit. In this pit water was tapped in the pipes at about 40 ft. below the original rock surface and the cavity found to be from 1 to 6 ft. thick. In the view the cavities are being washed out preparatory to grouting. In some of the pipes the spouting water may be noted.

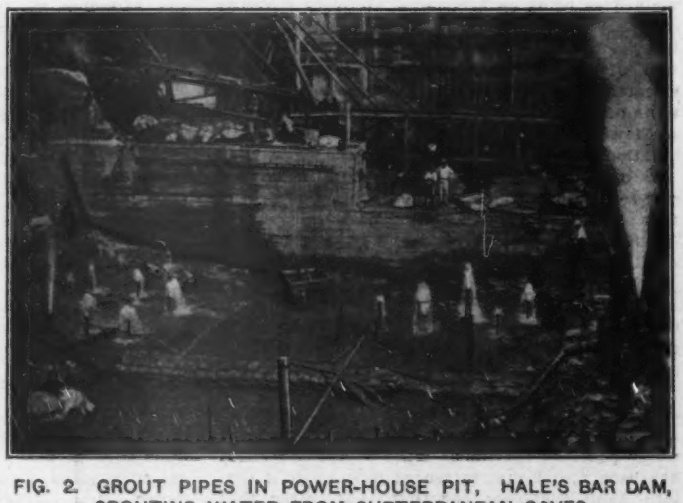

FIG. 2. GROUT PIPES IN POWER-HOUSE PIT, HALE'S BAR DAM, SPOUTING WATER FROM SUBTERRANEAN CAVES.

Fig. 1 is a view of one of the sections, which has been laid mostly dry. In the background the well-drilling outfits may be noted at work.

The Mechanical Handling of Baggage and Parcels at Large Railway Stations in Paris (France).*

Electric or hydraulic lifts are very generally used [for handling baggage at stations having the main floor above or below the track level]. These, like all appliances with reciprocating movements, have the disadvantage of giving only an intermittent and consequently rather limited output. This disadvantage is not felt so much in the case of outgoing baggage, which arrives at the station at different times, so that enough time is available for dealing with it. But it does apply to incoming baggage, which comes by the same train and should be quickly delivered to the passengers.

*From a statement made by Mr. Jullien, Chief Engineer of Way and Works, Orleans Ry. (France), and printed in the November number of the Bulletin of the International Railway Congress, 49 Rue de Poincon, Brussels.

At several stations this has led to the installation of endless belts, which give a much quicker service; for instance, at Paris (Quai d'Orsay and Invalides stations) and at Hamburg.

The conveyance of baggage by traveling endless belts, such as have been installed by the Orleans Railway at the Quai d'Orsay station (Paris), is worthy of some mention. Horizontal belts, placed below the main-line arrival platforms, receive the baggage through openings arranged in the platforms, and take it to inclined belts, which raise it to the first floor and tilt it on to a sorting table. Above the tables are placards showing the figures 0 to 9. All packages whose registered number ends with the same figure are placed on the table below the placard bearing that figure. As the registered number is given on the baggage ticket which the passenger received when he registered his baggage, he knows at once, by looking at this ticket where he has to look for his baggage.

The packages as they arrive at the sorting table are taken by porters who direct them to the right or left, according to the last figure of the registration number. The packages thus arrive on a movable table which carries them horizontally in front of the receiving table. In the space between the movable table and the receiving table there are porters (at each placard) who remove the baggage corresponding to a given figure and place it below the placard bearing that figure. The packages, as soon as they have been identified by the passengers, are then placed on the delivery tables, at their disposition. In order to facilitate the handling, the delivery table is a little lower than the sorting table, and this is again a little lower than the movable table.

With this system the delivery of the baggage is effected very much more quickly than with the ordinary system of loading the baggage on to a truck, running it to the delivery tables, and unloading it there. The time required for the operation only depends on the quickness with which the baggage can be unloaded from the car on to the platform.

At the Quai d'Orsay station, also, the time required for the passengers to leave the station has been materially reduced by placing at their disposal a moving staircase. The rate of movement of the passengers has been more than doubled by the use of this moving staircase.

The mechanical sorting of parcels is a feature at the Paris-Austerlitz station. This sorting is only carried out as regards the parcels dispatched from that station, amounting on the average to 30,000 per day, of which about 20,000 are sent grouped, either as complete carloads to large stations, or packed into baskets, either to the stations of sufficient importance or to groups of smaller stations.

The number of baskets dispatched each day from this station averages about 900. Nearly all the parcels use the evening trains and are handed in between 6 and 8 p. m. The parcels, according to their labels, are marked with chalk, with one of the figures 0, 1, 2, 3 or 4, and are thrown into one of the openings in the platforms. The figures 1, 2, 3 and 4 are used for the baskets only, and the figure 0 for full carloads.

An endless belt takes the parcels belonging to the first-class side of the basket service, to a sorting table, where (in accordance with the figures marked on them) they are transferred by sorting porters to the belt corresponding to the figure with which each is marked. They are thus taken to a storeroom bearing the corresponding figure. A first sorting operation by direction is thus effected.

When the time has come for getting ready a train corresponding to a given direction, the storeroom in question is opened and the parcels contained in it are placed on an endless belt passing along the bottom of it. The parcels are thus taken to a second sorting table, where there are seven inclined chutes to the reception tables.

Employees well acquainted with the railway system are placed at the sorting table for directing the parcels into the corresponding chute; others are placed at the reception tables. The latter place them into the baskets corresponding to the different stations or different groups of stations of the section.

The packages which are marked with the figure 0, and are hence intended for full carloads, only go through one sorting operation. They are directed into special storerooms, six in number, each corresponding to one large station on the railway system. There they are placed into six special chutes and pass into the cars under the action of gravity.

A Rutting Collision Between Two Trolley Cars on an electric railway between Kansas City and Leavenworth, Kan., Dec. 18, killed three persons and injured nine others. The accident occurred near Wolcott, and is ascribed to a heavy fog.

The Explosion of an Oil Tank on the British battleship "Orion," Dec. 12, injured the commanding officer, four engineer officers and 15 of the crew. The "Orion" is equipped for burning both oil fuel and coal.

Forest Fires in Massachusetts during the year 1911 burned over an area of nearly 100,000 acres, causing a damage estimated by the State Forester at $500,000. In 1910 the area burned was about 42,000 acres, and the damage a little over $200,000. The increase is ascribed to unusually dry weather during the spring and summer.

An Interurban Car Went Through a Bridge at Burlington, N. J., on Dec. 19. The bridge crosses Assiscunk Creek at East Pearl St. It was an iron bridge, 30 years old, and had been regarded as unsafe for some years. The car which wrecked the bridge was an unusually large one. It had only eight or ten passengers at the time, however, and these with the crew were taken out practically uninjured.

A Rear Collision on the Chicago, Milwaukee & St. Paul Ry., at Odessa, Minn., Dec. 18, killed 12 persons and injured 18 others. The Columbian express came to a stop soon after leaving Odessa and the flagman was sent back to warn the following train. He had gone only the length of the train, according to reports, when a fast freight train came up at 75 mi. per hr., wrecking the rear sleeping-car of the express. Only two of the 27 occupants of this car escaped without injury. The accident is ascribed to the failure of the signal operator at Odessa to protect the express train after it had stopped.

The British Admiralty Decision on the Collision between the cruiser "Hawke" and the White Star liner "Olympic" has just been announced. The Admiralty Court decides that the "Hawke" was not the overtaking steamship and hence that the "Olympic" was not entitled to the privileges of the leading ship. Blame for the collision is placed upon the "Olympic," but the court decided that the owners of the "Olympic" need not pay for the damages to the cruiser since the fault was the pilot's and the pilot was employed under compulsion of law. The captain of the "Olympic" is thus exonerated and the commander of the "Hawke" is also absolved from all blame for the collision. The court decides that the owners of each vessel must pay their own damages.

A Steam Shovel Was Wrecked by Dynamite Dec. 13 while working on relocation of the Panama R. R. in the Canal Zone, Panama, between Empire and Las Cascadas. The shovel struck an unexploded charge in a drill hole. Eight men were injured, three probably fatally.

A French Military Aviator, Lieut. Charles Lantheaume, was killed on Dec. 13, by a fall from his aeroplane at the aviation camp in Melun, after the completion of a cross-country flight of 35 miles. On December 6, at Filey, near Scarborough, Yorkshire, England, an aviator, Hubert Oxley, and his passenger, were killed by a fall from an aeroplane. The cause of these accidents are not given.

An Inch of Rain a Minute.—All Isthmian records of excessive rainfall for short periods were broken at Porto Bello on the night of Nov. 28-29, 1911, when approximately 2.46 ins. of rain fell in three minutes between 2.07 and 2.10 a. m. The highest previous records of excessive rainfall were 0.75 in. in five minutes at Rio Grande in July, 1903, and 1.24 ins. in ten minutes at Balboa in August, 1908. The total rainfall for the shower at Porto Bello was 7.60 ins.—Canal Record.

The Office of Public Roads of the Department of Agriculture asks for $70,000 additional appropriation for the next fiscal year "in order to broaden the scope of the advisory lecture, object lesson and experimental work of the Bureau." Last year's appropriation was $150,000.

The Tunis Monorail Railway, one mile in length on City Island, New York City, was placed in a receiver's hands last week on petition of the bondholders. The line has been in operation about two years, but carries a comparatively light traffic.

Two Building Collapses, due to disregard of the retardation of concrete setting by cold, were reported during the past week. At Waterdown, Ont., a portion of the concrete roof on a part of the plant of the National Fireproofing Company, Ltd., collapsed on Dec. 9. It caused the death of one man and the serious injury of two others. The roof had been put up about three weeks before, and the workmen were removing the supports. The report states that "it is thought the frost and damp weather of the last couple of weeks prevented the cement from setting." In Baltimore, Md., a two-story brick building being erected on Franklin St., for the American Ice Co., collapsed on Dec. 14, and buried two workmen, who were seriously wounded in the wreckage. This failure seems to have been due to the sudden sinking of a column supporting one of the main interior joints of the building. This column rested on a concrete foundation. The newspaper report states that the sinking of the column was probably due to the unsatisfactory condition of the concrete footings which had not set, owing to the cold weather. However, the unsatisfactory condition of the ground beneath the building seems to point to that rather than the retarded setting of the concrete.

Sixty-five Routes for Main Highways in Pennsylvania, including 2,755 of roads, have been surveyed by engineers of the State Highway Department during the past year, in accordance with the provisions of the Sproul Act of 1911. This work is preliminary to the proposed issue of $50,000,000 bonds for highway construction.

$250,000 Additional for Raising the "Maine" is provided in the general deficiency bill passed by the House of Representatives on Dec. 19. This will bring the total appropriation for this purpose up to $900,000, all of which is expected will be needed in raising the vessel. The bill, furthermore, permits the Secretary of War and the Secretary of the Navy to give a portion of the wrecked vessel to the Republic of Cuba, for the erection of a permanent memorial in Havana. It is also provided that the "Government may donate pieces of the battleship or of its equipment or the property found in it to any municipality of the United States, or to any military or naval association or society in the United States, or to the former officers and crews of the 'Maine,' or their heirs or representatives," provided these persons or institutions take proper care of the relics entrusted to them. A proposition to allow concessions to private parties to exhibit the wreck was voted down.

Personals.

Mr. Thomas E. Mitten has resigned his position as President of the Chicago City Ry. Co.

Mr. Henry F. Waige has been appointed City Engineer of Cincinnati, Ohio. He was formerly Chief Engineer of the Clinchfield Coal Co.

Mr. J. A. Zehner has been appointed Division Engineer of the Mahanoy Division of the Lehigh Valley R. R., to succeed Mr. M. H. Falcon, who died recently.

Mr. O. K. Morgan, formerly Chief Draftsman of the Carolina, Clinchfield & Ohio Ry., has been promoted to Office Engineer, not Chief Engineer, as noted in our issue of last week.

Mr. George B. Post, of New York City, has been presented with the Gold Medal of the American Institute of Architects. The presentation was made at Washington, D. C., Dec. 13.

Mr. G. B. Gilmer, formerly Assistant General Manager of the Texas Central R. R., has been appointed General Superintendent of the Missouri, Oklahoma and Gulf Railroad, with headquarters in Muskogee, Okla.

Mr. J. O. Crockett has resigned his position as General Manager of the Buffalo & Susquehanna Ry., and this position has been discontinued. Its duties will be assumed by Mr. E. R. Darlow, Assistant Receiver.

Mr. C. W. Stone, M. Am. Inst. E. E., formerly an Electrical Engineer with the General Electric Co., has been appointed Manager of the Lighting Department of that company to succeed Mr. C. B. Haskins, deceased.

Mr. W. H. Thompson, formerly Chief Engineer of the Illinois Traction System, has been appointed General Manager of the Des Moines Electric Co., a subsidiary of the Traction System. Mr. R. F. Carley succeeds Mr. Thompson as Chief Engineer.

Dr. Rossiter W. Raymond, M. Am. Inst. M. E., and Mr. Geo. F. Kunz, M. Am. Inst. M. E., were decorated with the Order of the Rising Sun by the Emperor of Japan during the recent visit of the American Institute of Mining Engineers to that country.

Mr. W. Pagan, M. Inst. C. E., has been appointed Deputy Commissioner of Railways of Queensland, Australia. He was formerly Chief Engineer of the Engineer's Branch of the Railway Department, in which position he is succeeded by Mr. N. G. Bell, M. Inst. C. E.

Mr. A. N. Bullitt has been appointed Chief Engineer of the Memphis & Pensacola R. R., present office, 1630 Exchange Bldg., Memphis, Tenn. We are informed that location work on this railroad will be begun early in January, when three parties will be put in the field.

Mr. C. F. Brown, Assoc. M. Am. Soc. C. E., and H. S. Kleinschmidt, Assoc. M. Am. Soc. C. E., have formed a partnership under the firm name of Brown & Kleinschmidt for a general civil and consulting engineering practice, with offices at 1005 Newhouse Bldg., Salt Lake City, Utah.

Mr. Elbert M. Chandler, formerly General Manager and Engineer of the Burbank Power & Water Co., of Burbank, Wash., has been appointed Receiver of that company in the Federal Court at Spokane. The property consists of a partly-developed 14,000-acre irrigation pumping project.

Mr. S. B. Redfield, M. Am. Soc. M. E., formerly Associate Editor of the American Machinist, has become Engineer of Tests of the Ingersoll-Rand Co., at their Phillipsburg plant. Mr. Redfield was employed in the engineering department of the Ingersoll-Rand Co. prior to his editorial experience.

Mr. W. H. Dawley, M. Am. Soc. C. E., Chief Engineer of the Yunnan, Szechuan & Teng Yueh Railway, with office at Yunnan Fu, China, is now at Hong Kong. This information was sent by cable a few days ago, and his friends will be glad to hear of his safety, in view of the present disturbances in China.

Mr. W. C. Armstrong, M. Am. Soc. C. E., has been appointed Engineer of Bridges of the Chicago & Northwestern Ry., with headquarters in Chicago, Ill., to succeed Mr. I. F. Stern, M. Am. Soc. C. E., whose resignation was noted in a recent issue of Engineering News. Mr. Armstrong was formerly Terminal Engineer of the same railway at Chicago.

Mr. Geo. H. Preston, Assoc. M. Am. Soc. C. E., has resigned his position as Structural Engineer with the Turner Construction Co., of New York City, to take a similar position with F. J. Ellithorpe & Co., 17 Battery Place, New York City, consulting engineers in connection with air-cushion installation for 28 Otis elevators in the new Woolworth Building.

Mr. M. M. Cooke, Assistant Engineer of the Wichita Falls & Northwestern Ry., has been made Chief Engineer to succeed Mr. R. A. Thompson, M. Am. Soc. C. E., who has resigned to accept the position of Chief Engineer of the California Railroad Commission. Mr. Thompson was Chief Engineer of the Texas Railroad Commission for nine years prior to his coming to the Wichita Falls system.

Mr. Geo. R. Winslow, of Syracuse, N. Y., has been appointed Chief Office Engineer of the California State Highway Commission. Seven divisional engineers of the Highway Commission have been appointed as follows: Mr. Walter C. Howe, Assoc. M. Am. Soc. C. E.; Mr. Thomas A. Bedford, M. Am. Soc. C. E.; Mr. Francis J. Somner, Mr. James B. Woodson, Mr. W. F. Caruthers and Mr. Wm. L. Clark.

Mr. John A. O'Connor, Assoc. M. Am. Soc. C. E., has been appointed Chief Engineer in charge of construction of the New York Barge Canal Terminals at a salary of $6,000 per year. Mr. Carleton Greene, of New York City, Assoc. M. Am. Soc. C. E., has been appointed Division Engineer at New York City and will have charge of the terminal work at that place. Mr. O'Connor was formerly Resident Engineer in the State Engineering Department at Albany, N. Y., and Mr. Greene was Resident Engineer at Schenectady, N. Y.

Mr. Robert Ridgway, M. Am. Soc. C. E., has been appointed Subway Construction Engineer by the New York Public Service Commission, at a salary of $10,000 per year. Mr. Ridgway was formerly Department Engineer with the Board of Water Supply of New York City, and is engaged at present upon the construction of the Catskill Water-Supply System. The appointment is to take effect on Jan. 1. Mr. Ridgway entered the New York City service in 1884 as a member of the engineering staff of the aqueduct commission.

Obituary.

Sumner Lyman Hunt, a building contractor of Syracuse, N. Y., died in that city December 12th, age 96 years.

Charles M. Crawford, Member of the Connecticut Society of Civil Engineers, died Dec. 14 at New Haven, Conn., aged 55 years. His brother, Mr. Joseph U. Crawford, is Consulting Engineer of the Pennsylvania Railroad at Philadelphia, Pa.

O. M. Laing, General Superintendent of the Central New England Ry., died in Hartford, Conn., Dec. 15, from typhoid fever. Mr. Laing was born in London, Ont., 39 years ago. He went to Hartford from Nashville, Tenn., in 1906, as Assistant Engineer of the Central New England Ry. He became General Superintendent in January, 1910.

Richmond Viall, Superintendent of the Brown & Sharpe Manufacturing Co., died Nov. 16, at Providence, R. I. Mr. Viall was born in Barrington, R. I., Dec. 16, 1834, and entered the employ of the Brown & Sharpe Mfg. Co. as a workman in 1863. He advanced by gradual stages to the position of Superintendent, which he held from 1878 until the time of his death.

Clarence W. H. Smith, U. S. Junior Engineer, died Dec. 10, at his home in Grand Rapids, Mich., from pneumonia. Mr. Smith was born in Burlington, Ia., 40 years ago, and graduated from the University of Iowa in civil engineering in the class of 1893. He had been employed in the U. S. Engineer Office at Grand Rapids since 1897. He is survived by his wife and an infant son.

Charles Coit Cokefair, Assoc. Am. Inst. E. E., President and General Manager of the Great Northern Development Co., of Duluth, Minn., died at his home in that city, Dec. 13. Mr. Cokefair was born at Bloomfield, N. J., in 1848. He was also President of the Interurban Power Co. of Minneapolis, Director of the Great Northern Power Co. of Duluth, and of the Bangor Royal Freight Co., Easton, Pa.

I. C. Johnson, a pioneer in the manufacture of Portland cement) or his successors. In this plant, land, aged nearly 101 years. Mr. Johnson was born in London, England, Jan. 28, 1811. About 1840 he left the well-known firm of White & Sons, cement and lime manufacturers, to take over a rundown cement plant formerly operated by Joseph Aspdin (credited with being the inventor of Portland cement) or his successors. In this plant, Mr. Johnson probably produced the first real Portland cement, as now known.

Leo E. Granke, a contractor, of Elgin, Ill., was killed by the fall of a derrick, July 25, 1911, at Decatur, Ill. The accident occurred during the construction of a dam across the Sangamon River, for which Mr. Granke held the contract, and is ascribed to the slipping of a clamp used in making a splice in one of the guy ropes of the derrick. Mr. Granke was born at Madison, Wis., 34 years ago, and was a graduate of the University of Wisconsin in civil engineering, class of 1900. After one year with the U. S. Geological Survey, he became a division engineer on the Chicago & Alton Ry., and in 1902-'05 was employed as an engineer in the U. S. Reclamation Service. From 1905 to '07 he was Superintendent of Construction for a contracting firm in Chicago, and in recent years he had become an independent contractor. Mr. Granke is survived by his wife and one child.

Engineering Societies.

COMING MEETINGS.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at St. Paul, Minn. Secy., J. B. Davidson, Ames, Iowa.

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
Dec. 27-Jan. 3. Annual meeting at Washington, D. C. Secy., L. O. Howard, Smithsonian Institution, Washington, D. C.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
Jan. 6. Annual meeting at Seattle, Wash. Secy., Joseph Jacobs, 803 Central Bldg., Seattle, Wash.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 9. Annual meeting at New York City. Secy., J. R. Wemlinger, 13 Park Row, New York City.

MINING AND METALLURGICAL SOCIETY OF AMERICA.
Jan. 9. Annual meeting at New York City. Secy., W. R. Ingalls, 505 Pearl St., New York City.

MICHIGAN ENGINEERING SOCIETY.
Jan. 9-11. Annual meeting at Lansing, Mich. Secy., Alba L. Holmes, 574 Wealthy Ave., Grand Rapids, Mich.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 16. Annual meeting at Pittsburgh, Pa. Secy., Elmer K. Hiles, 3511 Oliver Bldg., Pittsburgh, Pa.

WOOD PRESERVERS ASSOCIATION.
Jan. 16-18. Annual convention at Chicago, Ill. Secy., F. J. Angier, Mount Royal Station, Baltimore, Md.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at New York City. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORSS.
Jan. 17-19. Annual meeting at Urbana, Ill. Secy., E. E. R. Tratman, 1138 Monadnock Block, Chicago, Ill.

SOCIETY OF AUTOMOBILE ENGINEERS.
Jan. 18-20. Annual meeting at New York City. Secy., Coker F. Clarkson, 1451 Broadway, New York City.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
Jan. 23-25. Annual meeting at New York City. Secy., W. W. Macon, 29 West 39th St., New York City.

OHIO ENGINEERING SOCIETY.
Jan. 24-26. Annual meeting at Cleveland, Ohio. Secy., Clyde J. Knisely, New Philadelphia, Ohio.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 24-26. Annual meeting at Montreal, Que. Secy., C. H. McLeod, 413 Dorchester St., West, Montreal, Que.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 14-15. Annual meeting at Boston, Mass. Secy., N. W. Gifford, 26 Central Square, East Boston, Mass.

Engineers' Club of St. Louis.

The annual dinner was held at the Mercantile club, St. Louis, Mo., on Friday evening, Dec. 15th.

The New York Railroad Club.

The fifth annual Christmas entertainment and social reunion was held at the Engineering Societies Building in New York City on Friday evening, Dec. 15th.

Desmoines Engineers' Club.

Officers for the coming year have been elected as follows: President, Mr. L. H. Stone; Vice-President, Mr. J. E. Van Liew; Secretary-Treasurer, Mr. F. R. Hubbard.

The Canadian Society of Civil Engineers.

At the monthly meeting of this Society held Dec. 14 at Montreal, Mr. Guy M. Gest, of New York, gave an address on "Underground Conduit Construction," illustrated by motion photographs.

Albany Society of Civil Engineers.

At the regular meeting to be held at Albany, N. Y., Dec. 21, Mr. A. B. Lueder, of New York City, will give a lecture on "Erection of Bridges on the Uganda Railway, British East Africa."

American Society of Civil Engineers.

At the regular bi-monthly meeting of the San Francisco association of members of this Society, held in San Francisco, Cal., Dec. 15th, Mr. A. L. Bobbs gave an address on "Structural Design of the Main Towers and Campanile" of the St. Ignatius Club.

American Society of Engineer Draftsmen.

At the regular monthly meeting to be held in the Engineering Societies Building, New York City, Dec. 21, Mr. C. M. Shigley, of Columbus, Ohio, will present a paper entitled "Patent Office Drawings," and Mr. William H. Chorlton will give a lecture on "Bridge Drafting From the Engineer's Point of View."

American Institute of Mining Engineers.

At the December meeting of the New York section, held at the Engineering Societies Building, New York City, Dec. 20. Dr. R. W. Raymond, Secretary Emeritus, gave an account of the Institute party in Japan.

At the meeting to be held on January 5, Mr. Gardner F. Williams of Washington, D. C., will give an illustrated lecture on the South African diamond field.

Brooklyn Engineers' Club.

The 15th annual dinner was held at the Hamilton Club, Brooklyn, N. Y., December 15. Addresses were made by Commissioner of Accounts Fosdick, of New York City; by Senator Charles A. Towne, of Minnesota; Louis H. Pounds, Commissioner of Public Works, Brooklyn, and by W. H. Roberts, the retiring President.

Officers for the coming year were elected as follows: President, William P. Donnelly; Secretary, Joseph Strachan; Treasurer, James W. Nelson.

American Society of Agricultural Engineers.

At the fifth annual convention at the Hotel Ryan, St. Paul, Minn., Dec. 27-29, the address of welcome will be made by Dean Wood, of the University of Minnesota. After the president's address by Charles A. Ocock, of Madison, Wis., a program of papers will be presented, including the following: "Larger Farm Implements and the Cost of Crop Production," F. H. Demaree, Racine, Wis.; "Corn Planter Tests; Value and Method," C. O. Reed, Urbana, Ill.; "Some Agricultural Engineering Problems in Mexico," Stanley F. Morse; "The Agricultural Engineer in the West," C. R. Sessions; "Farm Building Location as a Factor Affecting Farm Labor Efficiency," L. W. Chase, Lincoln, Neb.; "Lighting Farm Buildings," H. H. Musselman, Lansing, Mich.; "Fuels for Internal Combustion Tractors," J. A. King, Charles City, Iowa; "The Small Farm Tractor," W. J. Brandon, Peoria, Ill.; "The Webster Magneto," Emil Podleska, Tulfin, Ohio; "The Need of Tractor Implements," Fred Glover, Minneapolis, Minn.

The last day of the convention will be given over to excursions to the University Farm and other points of interest around St. Paul and Minneapolis.

International Tramways' and Light Railways' Union.

The congress of this association in 1912 will be held at Christiania, Norway, but the exact date is not yet announced. The list of papers or reports to be presented is as follows:

(1) Influence of new methods of public transportation on the development and extension of large cities; A. Dausset, Paris. (2) Organization of street railway service for handling large crowds in important cities; M. Hradetzky, Vienna. (3) The use of motor cars on railways, and particularly on light railways; E. A. Ziffer, Vienna. (4) The use of direct current for electric traction; M. Bacqueyrisse, Paris. (5) Electrolysis and the methods employed for remedying its effects. (6) Maintenance and control of overhead trolley lines and feeders; E. Hoop, Brussels, and M. Otto, Berlin.

(7) The proper location of car sheds with relation to a street railway system; J. H. Nieszen, Amsterdam. (8) Corrugation or undulatory wear of rails; A. Busse, Berlin. (9) Removing snow from street railway tracks; M. Poppe, Christiania. (10) Traffic relations of light and local railways, interurban lines, and suburban and city street railways with main line steam railways for through traffic, transfers, freight and the interchange of rolling stock; M. Campiglio, Milan. (11) Various methods for keeping account of passenger receipts on light and local railways; G. Lembourg, Brussels. (12) Progress in methods of heating and lighting cars on light and local railways; F. de le Hoye, Brussels.

The offices of the association are at 15 Avenue de la Toison d'Or, Brussels, Belgium.

American Chemical Society.

The 45th meeting will be held in Washington, D. C., Dec. 27-30 at the McKinley Manual Training School, corner Seventh St. and Rhode Island Ave.

The session of the Division of Industrial Chemists and Chemical Engineers will be held on Saturday, Dec. 30, and the following papers will be presented at this session: "Relation of Ultimate Composition to Calorific Power in Coal," H. C. Sherman, D. A. Bartlett and M. E. Weatherless; "Relation of Proximate Composition to Calorific Power in Coal," H. C. Sherman and H. S. Regester; "New Forms of Gas Analysis Apparatus, "T. A. Burrell; "New Forms of Apparatus for Gas Analysis," F. M. Williams; "Problems in the Manufacture of C. P. Acids," H. T. Baker; "A Rapid Method for the Determination of Vanadium in Steels, Ore, Etc., Based On Its Quantitative Inclusions by the Phospho-molybdate Precipitate," J. R. Cain and J. C. Hostetter; "Valuation of Fluorspar," Ernst Bittel; "The Quality of Commercial Kerosene," L. D. Lockhart; "Notes on a New Type of Extraction Thimble," P. A. Boeck; "The Effect of Filtration on the Physical Properties of Petroleum Oil," John P. Simmons; "The Direct Determination of Small Amounts of Platinum in Ores and Bullion," F. P. Dewey; "The Product Patent," Franklin Field Sommers.

Meetings of the Section on India rubber chemistry will be held on Friday and Saturday and the following papers will be presented: "Scientific Methods in Tests for Rubber Contents in Raw and Vulcanized Rubber," Wilhelm A. Ducca; "On Mineral Compounds in Rubber," S. T. Thatcher. The following subjects will be brought up for discussion: "Synthetic Rubber," "The Effect of Oils and Other Adulterants in Reclaiming Rubber," "The Treatment of Crude Rubber," "Uses of Ceylon Rubber."

Among the papers to be presented before the Division of Agricultural and Food Chemistry, whose session will be held on Saturday afternoon, Dec. 30, are the following: "A Study of the Pollution of the Ohio River Bordering Indiana," H. E. Barnard; "An Electrical Conductivity Test for Purity of Maple Syrup," J. F. Snell.

The address of President Alexander Smith, entitled "An Early Physical Chemist," will be given at the Thursday evening session, Dec. 28.

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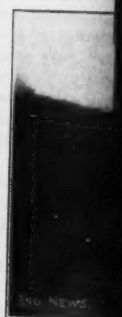

FIGS. 1 A